Examining Risk Perception and its Influence on

Treatment Adherence in Those with Type II Diabetes Mellitus

A DISSERTATION
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Acknowledgements

Deciding to pursue a Ph.D. after already completing undergraduate and professional degrees was surprisingly easy for me. I have told this story verbally countless times, and it is about time that I get it down in writing.

I had decided early on in my Pharm.D. education that I wanted to go into the SAPh PhD program at the University of Minnesota after becoming a pharmacist. Sure, plenty of people questioned my decision, but I knew it was the right decision for me.

I was fortunate to initially begin my pharmacy career by volunteering for Dr. Mike Swanoski, and shortly after I was hired on as a pharmacy technician. Even though this was a great experience in an exemplary community pharmacy with an excellent pharmacist, I knew I needed something different for a career. During the summer after my PDII year, I was able to partake in an internship with Indian Health Service on the White Earth Indian Reservation. The Indian Health Service is the *crème dela crème* of the community pharmacy world—spacious, with individual consulting rooms, a focus on appropriate therapy, and the ability to take the necessary counseling time with each patient. While I wasn't a pharmacist at that point, I still left the pharmacy each day thinking, "If I'm not loving this work, then I'm not meant to be a community pharmacist."

During this same time I was engaging in coursework for the Leadership Emphasis Area at the UMN CoP. This coursework forced intrapersonal communication and self-actualization that I would not have practiced otherwise. It was then when I realized studying leadership and leadership education was a discipline in and of itself that I knew a PhD was for sure the perfect fit for me. While I did not end up focusing on leadership education for my dissertation, it was the area that firmed up my short-term career plans.

My graduate school experience did not start the way I would have wanted it to—promises regarding my payments were changed last minute, and I was left making half of what I anticipated, which was compounded by the fact that I was giving up a six figure pharmacist salary and was needing to pay back six figures of pharmacy school debt! While it was a frustrating first few couple of weeks, I am forever grateful that I pushed through.

I originally came up with my dissertation idea after a chance meeting at the Fitger's Brewhouse in Duluth. Sitting at the bar, a local craft brew in one hand and a research article in the other, a gentleman in a sharp grey suit saddled up next to me. Hearing he wasn't from the area, I struck up a conversation with him and discovered that he had earlier that day interviewed for an assistant professor position at UMD. He proceeded to discuss his dissertation, and how he used a "Risk Theory" framework for his research. This singular chance conversation introduced me to risk perception, which started me on this path discovering how risk perception influences treatment behavior in those with chronic disease. I chose to study this in patients with diabetes because it's a growing epidemic across the world, and because pharmacological and non-pharmacological treatments are extremely effective if followed consistently.

I pursued this idea throughout the rest of my didactic graduate school education and used class assignments to further explore the idea. I approached Dr. Tim Stratton with a *rough* draft proposal of my project during the spring of my second year of graduate school, and as they say, "the rest is history."

A thank you to my parents and brothers—while they didn't understand why I needed more schooling, at least they didn't outright tell me that I was crazy (to my face)!

I need to thank many people at the College of Pharmacy. First, a thank you to my fellow graduate students, Drs. Dan Tomaszewski, Ben Aronson, and Maggie Kading. We were not always productive, but we had some great conversations! A special thanks to my advisor, Dr. Tim Stratton, who was willing to help me with my research and was always timely with his thorough feedback from the beginning. A thank you to Dr. Randy Seifert who has been and continues to be a great mentor and friend. To my committee members from the University of Minnesota: Drs. Jon Schommer, Michelle Johnson-Jennings, and Todd Rockwood—I appreciate the feedback and support you provided me along the way. I would like to specially thank and acknowledge Dr. Steve Waring and Paul Hitz, both from the Essentia Institute of Rural Health, who helped guide me through the difficult process of conducting research within a large health system.

I'd like to thank my wife Kristen for working long hours and picking up overtime shifts while I played at school. Her work and support made this endeavor much easier for me. Yes, Kristen, you can retire four years earlier then me…

Dedication

To my wife Kristen who provided unwavering support throughout the dissertation process, and to my son Graham who provided me many excuses to take breaks from writing.

Examining Risk Perception and its Influence on Treatment Adherence in Those with Type II Diabetes Mellitus

Reid C. Smith

Background: Type 2 diabetes mellitus (T2DM), has quickly become a national epidemic. Adherence to therapies is critical in attempting to ward off complications associated with uncontrolled diabetes. Adherence to therapies remains weak even with advancements in treatment options. Predictors for nonadherence have been studied for several decades. Prescription medication risk perception has been measured and compared between people who completely abstain from medications to treat previously-diagnosed conditions and those who decide to treat using medications. Additionally, perceived risk of disease and of routine risks encountered throughout life have been related to self-care adherence in patients with T2DM. The relationship between risk perception and self-care adherence is an area needing study.

Aim: The purpose of this study was to examine the relationship between perception of risk and treatment adherence in adults who have T2DM.

Method: A random sample of 381 subjects being treated for T2DM completed a comprehensive Internet-based survey. Along with demographic characteristics the questionnaire contained several scales related to harm and benefit perception, perceived threat of diabetes, self-efficacy, and adherence to diabetes-related self-care treatments.

Results: Significant differences were found in perceived risk of oral hypoglycemics between respondents using oral drugs for T2DM vs. those who were not. Likewise, significant differences in risk perception of oral hypoglycemics were observed between men and women. Adherence to self-care treatments was variable, with over one in three respondents having poor medication adherence, and the average number of days exercised in the week leading up to survey completion was less than three days. Adherence to some self-care treatments appears to be significantly related to risk perception.

Conclusion: Individuals with T2DM perceive medications for diabetes and its related comorbidities to be of high benefit and low harm. Adherence to exercise, diet, and medication recommendations was relatively low. Results indicate a potential link between risk perceptions and adherence to diabetes-related self-care treatments. Gaining insight into how persons with T2DM perceive the harms and benefits of diabetes-related self-care treatments in relation to risks and benefits of other medical and nonmedical products and activities may help with other areas of diabetes treatment adherence research.

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CHAPTER 1: INTRODUCTION

Type 2 diabetes mellitus (T2DM), has quickly become a national epidemic. It is estimated that 10.3% of Americans have T2DM, compared with less than 5% in Japan and the United Kingdom (*IDF Diabetes Atlas*, 2009). Additionally, approximately 1 out of every 8 dollars ($176 billion) spent on medical care in the United States is directly attributed to T2DM (American Diabetes Association, 2012). Adherence to therapies has not substantially improved for decades (Vermeire, Hearnshaw, Van Royen, & Denekens, 2001). Because DM is projected to affect 48.3 million people in the United States by 2050 (Narayan, Boyle, Geiss, Saaddine, & Thompson, 2006), improving treatment adherence in those with T2DM is of critical importance.

Evidence has been collected for several decades that connect health beliefs to treatment adherence (DiMatteo, Haskard, & Williams, 2007). Differences in prescription medication risk perception have been detected between those that completely abstain from medications for previously diagnosed conditions and those that decide to medicate (Slovic, Peters, Grana, Berger, & Dieck, 2007). Additionally, perceived risk of disease and of the environment has been related to treatment adherence in patients with T2DM (Shreck, Gonzalez, Cohen, & Walker, 2013). Understanding the relationship between prescription medication risk perception and treatment adherence is an area needing study.

Aims

The goal of this explanatory, descriptive study was to critically test the relationship between risk perception and adherence to self-care activities in the context of the Health Belief Model (Janz & Becker, 1984). The research question asked was, "How does risk perception among patients with type 2 diabetes mellitus influence adherence to treatments related to diabetes?" The specific aims of the study were:

Aim 1: To quantitatively describe risk perception in persons with T2DM.

Aim 2: To describe levels of adherence for diabetes self-care behaviors, including medication use, diet, exercise, foot care, smoking, and self-monitoring of blood glucose.

Aim 3: To examine the relationship between risk perception and adherence to diabetes self-care behaviors, including medication use, diet, exercise, foot care, smoking, and self-monitoring of blood glucose.

Significance

Poor adherence with medications is a critical issue among patients who have T2DM. Increasing rates of treatment plan adherence is critical from both economic and public health perspectives. This study adds to existing work in the area. Additionally, a more complete understanding of how risk perception is associated with treatment adherence will influence future efforts to create patient education and adherence initiatives. As all chronic illnesses are plagued by treatment nonadherence, this area of research is potentially applicable to many chronic conditions.

Health Care Costs and Chronic Disease in the U.S.

It is well known that the United States faces a number of challenges related to health care, as it ranks 37th in overall efficiency according to the World Health Organization (Tandon, Murray, Lauer, & Evans, 2000). While the available technology combined with the training and skill of the United States' health professionals may be unmatched, health care costs are rising at an unsustainable rate. Health care costs are increasingly consuming a larger share of both private and public assets ("Main economic indicators," 2009).

There is increasing incidence and prevalence of debilitating chronic diseases in the United States. Chronic diseases, or those diseases that are long lasting and often incurable, currently affect 45% of the U.S. population. Chronic diseases place tremendous strain on health care budgets as they account for 91% of filled prescriptions and 81% of all hospital admissions (Partnership to Fight Chronic Disease, 2007). It is reported that chronic diseases account for 70% of American deaths, of which many have safe and effective medications with proven morbidity and mortality benefits (Kung, Hoyert, Xu, & Murphy, 2008). Because such a large portion of the United States government's budget is spent on health care through public institutions and programs such as the Veterans Health Administration, Indian Health Service, Military Health System, Medicare, Medicaid, and State Children's Health Insurance Programs (S-CHIP), it is increasingly clear that the country's future economic viability requires controlling health care costs associated with the progression of chronic disease.

Type II Diabetes Mellitus

A new diagnosis of T2DM is life changing. Not only does a T2DM diagnosis require substantial lifestyle modifications such as changes in diet and an increase in regular physical activity, but T2DM also necessitates multiple oral medications for most patients and injectable insulin for more severe cases. Making the decision to start a new chronic medication therapy may cause mixed emotions. For some, taking medication might signify a loss of control, a feeling of getting older, or embarrassment, while for others initiating medication may offer a sense of control over a potentially debilitating condition (Shoemaker & Ramalho de Oliveira, 2008).

For those with a new or existing diagnosis of T2DM, existing therapies in conjunction with lifestyle modifications can limit the disease's potential short-term and long-term adverse effects (Warren, 2004). The Centers for Disease Control and Prevention (2008) rank diabetes as a leading cause of lower-leg amputations, retinopathy, and nephropathy in the United States, all of which are potentially preventable if treatment regimens are adhered to. Regrettably, these substantial risks are not enough to motivate some patients to action. More than 20% of patients are nonadherent to therapies, which leads to a statistically significant increase in all-cause hospitalization and all-cause mortality (Ho, Rumsfeld, Masoudi, McClure,…, & Magid, 2006).

Risk Perception

Risk perception has been measured using the psychometric paradigm approach for over three decades (Slovic, 1984). Measuring risk perception using this approach initially yielded quantifiable risk perceptions in nine different dimensions, which consist of voluntariness of risk, immediacy of effect, knowledge of risk to those exposed, knowledge of risk known to science, control, newness, chronic-catastrophic, common-dread, and severity of consequences (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978). Principal components factor analysis of these dimensions identified two factors: technological risk and severity. This early research suggested that it is possible to quantitatively measure individuals' risk perceptions (Fischhoff et al., 1978).

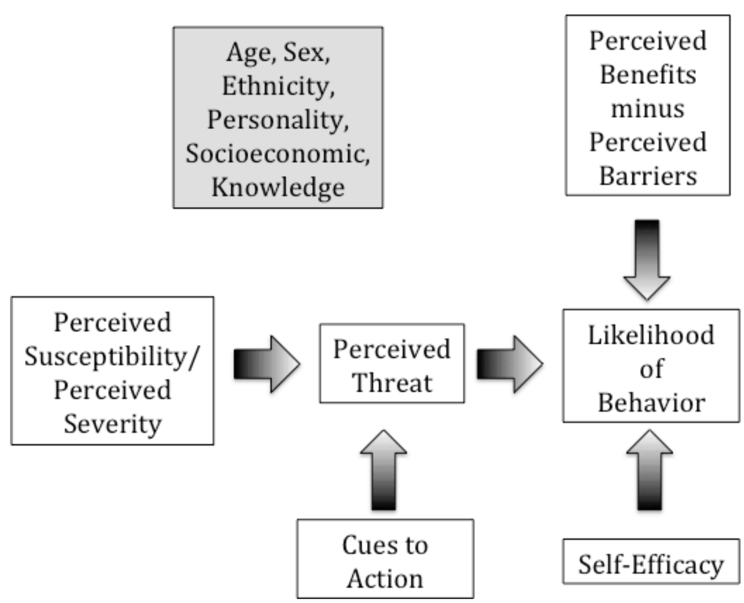
Walker, Caban, and Schechter (2007) created the Risk Perception Survey—Diabetes Mellitus survey tool, which is based off of the initial work by Fischhoff et al. (1978) to measure comparative risk perceptions in a minority, urban population. This was the first health tool developed specifically for measuring risk perception in patients with a pre-existing diagnosis of T2DM. The tool seeks to quantify individuals' perceptions of risks of the disease and of the environment. While there is research to support the hypothesis that risk perception does indeed influence treatment adherence (Walker et al., 2007; Shreck, Gonzalez, Cohen, & Walker, 2013; Slovic, Peters, Grana, Berger, & Dieck, 2007), the available research does not specifically address the relationship between perceived harm and benefit of prescription medications and treatment adherence.

Model of Investigation

The Health Belief Model (HBM) has been used for over 50 years and was created to try to explain why people generally do not participate in screening tests or partake in disease prevention activities for asymptomatic diseases (Janz & Becker, 1984). The model originally consisted of four components: perceived severity, perceived susceptibility, perceived benefits, and perceived barriers, but has since been expanded to include additional concepts including self-efficacy and locus of control (see Figure 1; Rosenstock, Strecher, & Becker, 1988). An internalized cost-benefit analysis (perceived benefits minus perceived barriers) is thought to influence an individual's likelihood of action. When an individual conducts her/his own cost-benefit analysis, she/he will weigh the possible benefits of executing a particular action against the associated costs or risks (e.g. financial costs, side effects, pain; see Janz & Becker, 1984). The risk of short- and long-term consequences of untreated diabetes can be significant, and the potential adverse effects of possible therapy options can be devastating. Thus, perceived risk of medications (a barrier to the likelihood of treatment in the HBM) plays an important role in an individual's decision to adhere to medication therapy. Perceived susceptibility and perceived threat can be combined and subsequently measured using the construct of perceived threat (Carpenter, 2005).

The HBM provides an appropriate framework for adherence research. The HBM predicts health related behaviors and includes many factors that influence medication adherence. Understanding risk perception vis-à-vis HBM may enhance scientific understanding of factors contributing to nonadherence, help to improve adherence initiatives, and ultimately lead to increased adherence in those with T2DM.

Figure 1. Adapted Health Belief Model



Adapted and modified from Stretcher & Rosenstock (1997).

CHAPTER 2: REVIEW OF THE LITERATURE

The purpose of the present explanatory, descriptive study was to address the perceptions of risk and its relationship with self-care adherence in those T2DM. This chapter will review the literature related to risk perception in persons with T2DM and its relation to self-care adherence. The review is structured in accordance with the theoretical model of inquiry used to guide this study—the Health Belief Model (Stretcher & Rosenstock, 1997). Using this model, the review describes harm perception and benefit perception as a cost-benefit analysis to self-care, perceived threat as a combination of perceived severity and perceived susceptibility, and additional factors found to influence adherence to self-care behaviors.

Risk Perception

Risk perception has been studied in a variety of ways for many decades. Starr (1969) utilized a psychometric approach when studying risk perception to measure the relationship between social benefit and technological risk. Starr believed that risk perception could be measured by using a "revealed preference" approach because society, through trial and error, has balanced benefits with acceptable risks of an activity (Fischhoff et al., 1978). Of note, among his many conclusions Starr (1969) suggested that the level of risk tolerated for hazards that are undertaken voluntarily (e.g. downhill skiing or medication) is similar to the level of risk from disease.

In response to Starr's original work, Fischoff et al. (1978) utilized an "expressed preference" approach to understanding risk, which showed that risk perception is predictable and quantifiable (Slovic, 1987). Fischoff et al.'s (1978) conclusions from their groundbreaking work differed slightly from the conclusions reached by Starr. Chiefly, activities that are entered voluntarily are considered no less risky than those entered involuntary as long as those activities have a perceived equal level of benefit. As highlighted in the introduction, risk perception is believed to fall into nine dimensions. Fischoff et al. (1978) concluded that these dimensions can be reduced to two factors: 1) high- and low-technology activities, with high-technology activities being those that are involuntary, new, poorly understood, and having delayed consequences, and 2) certainty of death should an individual be subjected to the activity or condition. In a review of "expressed preference" risk perception research, Slovic (1987) commented that perhaps the most important realization is that lay people and experts view risk assessment differently, and that lay people often lack certain information regarding hazards, but their perception of risk is often much richer and considers concerns that are often forgotten by experts. Thus, health providers must be cognizant of each patient's individual concept of risk when discussing health-related decisions. Individuals can be both risk averse and risk-seeking across differing domains (Weber, Blais, & Betz, 2002). An individual might be risk averse when it comes to financial decisions (e.g. gambling), but risk-seeking when making recreational decisions (e.g. camping alone in the woods). Risk aversion in one aspect of life does not coincide to risk aversion in every aspect.

Three separate studies have measured risk perception of prescription drugs in the countries of Canada (Slovic, Kraus, Lappe, & Major, 1991), Sweden (Slovic, Kraus, Lappe, Letzel, & Malmfors, 1989), and the United States (Slovic, Peters, Grana, Berger, & Dieck, 2007). These studies aimed to quantitatively measure the public's perceptions of benefit and perceptions of harm of prescription drugs for various disease states. Additionally, the study provided baseline risk perception data to help measure future trends and place prescription drug perceptions in a broader context regarding risk of other activities and technologies (Slovic et al., 2007).

Overall, in the study conducted in the U.S., prescription medication was perceived to be of high benefit and of low risk, which is similar to the results gathered in Canada and Sweden (Slovic et al., 2007). This favorable perception did not hold for all drugs, as medications for diet, sleep, and depression were not viewed as positively. Risk and benefit perceptions were different across gender and ethnic categories for several broad medication classes. Cost of medications was the predominant concern regarding prescription medications for subjects. Occurrence of side effects was not only associated with increased risk, but side effects were also associated with higher perceptions of benefit. However, subjects who had experienced a recent side effect had less favorable medication perceptions than those subjects whom had greater time lapse between side effects.

Diabetes Mellitus

In wanting to measure health professionals' risk perception towards diabetes, Walker, Kalten, Mertz, & Flynn (2003) created the *Risk Perception Survey for Developing Diabetes* (RPS-DD) based off of work by Slovic (1987) that was initially given to physicians, later to pharmacists (Pinelli, Berlie, Slaughter, & Jaber, 2009), women with a history of gestational diabetes (Kim, McEwen, Piette, Goewey, Ferrara, & Walker, 2007), and was eventually adapted to the *Risk Perception Survey—Diabetes*

Mellitus (RPS-DM; Walker, E.A., Caban, A., Schechter, C.B., Basch, C.E., Blanco, E., DeWitt, T…, & Mojica, G., 2007) for use in patients with a history of diabetes (Walker et al., 2007; Shreck et al., 2013).

In Walker et al. (2003), physicians showed moderate comparative risk perceptions for both disease and environmental risk, believed they had a sense of control over developing diabetes, and thought that they were less likely than others to develop diabetes. Similarly, in Pinelli et al. (2009) pharmacists indicated they had moderate comparative risk perceptions for both disease and environmental risk. Pharmacists also believed that they were less likely to develop diabetes compared to others and that they had more personal control in developing the disease.

The RPS-DM was first developed to measure comparative risk perceptions in a multiethnic, urban minority sample of patients with T2DM who were participating in a study to improve diabetic retinopathy screening rates (Walker et al., 2007). The participants indicated that 42.4% were Hispanic and 44% were Black and was given in both English and Spanish versions. Comparative risk perceptions were statistically significant for several demographic variables. While the RPS-DD and RPS-DM differed slightly in language, the authors felt the questions were similar enough to make comparisons between this multiethnic, urban minority population and the physician sample studied in Walker et al. (2003). Tests for statistical significance were not undertaken, but this patient population had a lower mean score for Personal Control (lower scores indicate a feeling of less control), a higher mean score on the Optimistic Bias scale (higher scores indicate more optimistic bias), and a higher mean score on the

Comparative Environmental Risk scale compared to the physician group (Walker et al., 2007).

In a separate study, the RPS-DM was completed by 526 lower-income, urban dwelling participants with diabetes, who were members of the same union/employer health benefit plan, and were either current or recent healthcare workers, or their spouses (Shreck et al., 2013). This was the first longitudinal study using the RPS-DM, and compared risk perception with diabetes self-care (measured using The Summary of Diabetes Self-Care Activities; Toobert, Hampson, & Glasgow, 2000) at baseline and at 1-year after receiving telephonic or paper behavioral interventions every 4 to 6 weeks during the study period. Compared to the previously mentioned studies, Shreck and colleagues used an aggregate risk perception score that combined the subscales found in the RPS-DM in their hypotheses. However, it was indicated that the separate risk perception components did have significant associations in a logistic regression model with dietary adherence, number of days eating high-fat foods, medication adherence, and days participating in specific exercise.

Medication Adherence in Diabetes

To improve the quality and efficiency of the health care system, Berwick, Nolan, and Whittington (2008) suggest that the focus must be on the triple aim of improving individualized care, improving the overall health of the population, and reducing costs. Medication adherence is a term generally defined as the proportion of the time that an individual takes a medication as directed (Osterberg & Blaschke, 2005). Medication nonadherence can have drastic consequences for patients' outcomes, and can be calculated on a range from zero to one hundred percent. As an example, if a pregnant patient only takes a once-daily prenatal vitamin every other day then her adherence would be 50%. Oftentimes in research an adherence value of 80% will be used to differentiate those who are adherent versus those who lack adherence (Choudhry et al., 2009). This value is arbitrary and has no real clinical significance as some medications can be taken less than 80% of the time with no ill effect while others need to be taken 100% of the time (e.g. drugs for HIV/AIDS) for optimal benefit.

It is estimated that the cost of poor medication adherence in the United States exceeds $100 billion annually (Dunbar-Jacob & Mortimer-Stephens, 2001). Medication nonadherence is so prevalent throughout this country that focusing on this issue will help improve individualized care, improve the overall health of the population, and reduce costs.

Poor medication adherence has many social, behavioral, and economic antecedents (Osterberg & Blaschke, 2005). Even though much research has been directed towards elucidating causal factors, little is known about how to improve medication nonadherence (Osterberg & Blaschke, 2005). Improving adherence rates would have tremendous effects on lowering healthcare costs and reducing the risk for future adverse health events (Gibson, Song, Alemayehu, Wang, …, & Forma, 2010). In a comprehensive review of barriers to adherence, Gellad, Grenard, and McGlynn (2009) state, "The literature on barriers to medication adherence is heterogeneous and of variable quality." The authors conclude that available data only support policy recommendations for the following four modifiable adherence barriers (Gellad et al., 2009):

1. Cost-sharing;
2. Depression (especially in those with diabetes);
3. Regimen complexity; and
4. Medication beliefs.

High quality research is needed to elucidate all of the many contributors to poor adherence.

In a Cochrane review of literature supporting interventions to enhance adherence, Haynes, Ackloo, Sahota, McDonald, and Yao (2008) found three studies pertaining to interventions to improve adherence in patients with T2DM that met inclusion criteria. Interventions were intensive (e.g. regular follow-ups via telephone) and had variable benefits (e.g. adherence improved, but the clinical marker HbA1c was not significantly different). Despite the increasing research in the area of medication adherence, the effectiveness of available interventions to improve adherence is limited (Haynes et al., 2008).

Non-medication Self-Care Adherence in Diabetes

In conjunction with medications, it is recommended that those diagnosed with T2DM follow several self-care strategies to decrease the risk of complications from T2DM. Diabetes self-care consists of a wide range of activities, which include diet, exercise, foot care, and self-monitoring of blood glucose. Patients that are able to adhere to recommended self-care activities are often rewarded with exceptional glycemic control and a decrease in complications associated with the disease (Delamater, 2006).

Similar to nonadherence concerns with medications, patients are routinely nonadherent to other forms of self-care. In a nationally representative sample of health maintenance organization enrollees (n=4,839; Lin, Katon, Von Korff, Rutter,…,Young, 2004) only 10% of respondents indicated that they followed a health diet plan, and nearly half (47.8%) of respondents exercised no more than 1 day per week. Similarly one out of four individuals indicated that they rarely self-monitor blood glucose as recommended (25.8%) and one in five individuals (20.1%) check their feet less than twice weekly (Lin et al., 2004).

As with medication adherence, causes of nonadherence to the previously mentioned self-care activities are multifactorial. Beliefs play an important role in adherence. Beliefs about the illness and the treatments themselves, self-efficacy, locus of control, coping strategies, and perception of relationship with care provider have all been associated with self-care adherence (Gherman, Schnur, Montgomery, Sassu, Veresiu, & David, 2011). Additional psychosocial issues that have shown to impact adherence to self-care include low levels of family support and depression (Glasgow, Toobert, & Gillette, 2001).

CHAPTER 3: METHODOLOGY

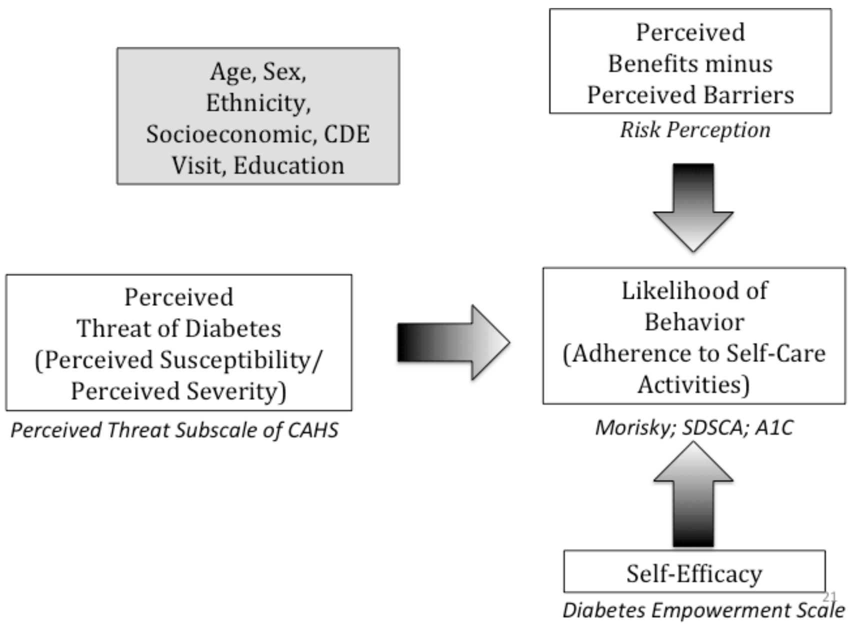
The purpose of this explanatory, descriptive study was to address the perceptions of risk and its relationship with self-care adherence in those with type 2 diabetes mellitus. The research question asked was, "How does risk perception among patients with type 2 diabetes mellitus influence adherence to treatments related to diabetes?" Specifically, the aims of this study are:

Aim 1: To quantitatively describe risk perception in persons with T2DM.

Aim 2: To describe levels of adherence for diabetes self-care behaviors, including medication use, diet, exercise, foot care, smoking, and self-monitoring of blood glucose.

Aim 3: To examine the relationship between risk perception and adherence to diabetes self-care behaviors, including medication use, diet, exercise, foot care, smoking, and self-monitoring of blood glucose.

Figure 2. Adapted Health Belief Model Including Study Scales



Variable Definitions

Please reference the model in Figure 2 when reading the definitions below.

Risk Perception

<u>Conceptual Definition</u>

Risk has many different conceptual definitions in the literature (Aven & Renn, 2009). Thus, it is difficult to conceptually define risk using one definition that encompasses all forms of risk. For the purpose of this research, the following definition of risk by Renn (2005) will be utilized: "an uncertain consequence of an event or an activity with respect to something that humans value." It is key to note that risks are only taken for something that humans' value. Assuming humans are rational, risks are only taken if there is potential for a reward. Furthermore, "an uncertain consequence" can be either positive or negative. Thus, risk perception will be gauged by measuring both perception of harm and benefit.

Operational Definition

Risk perception was measured using the technique pioneered in Slovic et al. (1989) and used most recently in a large study in the United States (Slovic et al., 2007). These studies used a technique that has previously been described as the psychometric paradigm. This technique assumes to quantitatively measure individuals' risk perceptions of technologies and activities. To measure harm perception, survey participants were asked to answer the following: "To what extent would you say that people who are exposed to this item are at risk of experiencing personal harm from it?" The possible responses ranged from 1 (They are not at risk) to 7 (They are very much at risk). The rating scales were anchored by the two descriptive phrases, but did not include descriptive phrases for intermediate responses.

Benefit perception was measured with the same technique used to measure harm perception, as described above. The benefit question asked was, "In general, how beneficial do you consider this item to be?" The possible responses will range from 1 (Not at all beneficial) to 7 (Very beneficial). Equivalent to the harm perception response categories, the benefit perception rating scales were anchored by the two descriptive phrases, but did not include descriptive phrases for intermediate responses. The benefit perception question had the same exact items (i.e. prescription drugs, technologies, and activities) as the risk perception question. Approximate time to complete the harm and benefit questions was twenty minutes.

Risk perceptions were gathered for various hazardous items, including: the individual item "prescription drugs", 23 additional pharmaceutical items by category (e.g. Drugs for Cholesterol) or specific drug types (e.g. aspirin), 6 medical tests or procedures (e.g. heart surgery, acupuncture, and medical x-rays), and 16 nonmedical hazards (e.g. cell phones, cigarette smoking, and high-sugar foods). See Appendix 1 for a complete list of the hazardous items. Collecting nondrug and nonmedical hazard risk perception data allows for placing the prescription drug risk perception in a broader context.

For this study, some of the pharmaceutical items were eliminated from the original item list in order to reduce participant survey fatigue. "Drugs for diabetes", "Over-the-counter (OTC) drugs", "Drugs for neuropathy" (nerve pain), and "Influenza vaccine" will be added to the pharmaceutical items list. "Self-Monitoring of Blood Glucose (blood glucose lancet)" will be added to the medical procedures list. Finally, "moderate-intensity exercise", "electronic cigarettes", and "high-sugar foods" will be added to the nonmedical hazards list.

Perceived Threat

Conceptual Definition

Perceived threat is defined as a combination of the perceived severity and perceived susceptibility constructs in the Health Belief Model (Sturges & Rogers, 1996). Specifically, perceived threat is an individual's perception of an anticipated harm that is derived from a cognitive appraisal of an event or cue (Carpenter, 2005).

Operational Definition

Perceived threat was measured using the threat subscale found in the Cognitive Appraisal of Health Scale (CAHS; Kessler, 1998). The Kessler (1998) study used an exploratory factor analysis on an original scale of 31 items with four hypothesized subscales that was given to a sample of 201 women with breast cancer. The threat subscale was found to consist of 5 items that had an internal consistency alpha coefficient of 0.85. Similarly, Carpenter (2012) used an exploratory factor analysis on 80 individuals with diabetes. In this population the same 5 items were found to fit together in the threat subscale with an alpha coefficient of 0.69.

Although in previous studies participants were asked to complete the entire CAHS, it was decided to decrease respondent burden by only including the threat subscale as mentioned in Kessler (1998) and Carpenter (2012). The threat subscale consists of 5 items that had 5 possible response categories from 1 (strongly disagree) to 5 (strongly agree). The threat subscale was scored by adding the 5 answers together for a total range of possible scores from 5-25. See Appendix 2 for a list of the questions.

Adherence

Conceptual Definition

For this study, adherence will be defined as the rate at which recommended self-care tasks for T2DM were followed. Recommended self-care tasks were taken from the

"Standards of Medical Care in Diabetes—2013" by the American Diabetes Association. The recommended self-care tasks included medication management, diet, exercise, foot care, smoking, and self-monitoring of blood glucose (SMBG).

Operational Definition

Adherence to medications will be measured using the Morisky Scale (Morisky, Green, & Levine,1986) and adherence to diet, exercise, foot care, smoking, and SMBG will be measured using the Summary of Diabetes Self-Care Activities (SDSCA; Toobert, Hampson, & Glasgow, 2000).

The Morisky Medication Adherence Scale (MMAS) is an eight- or four-item instrument initially tested for validity in a sample of 290 patients with hypertension (Morisky, Green, & Levine, 1986). The original 4-item scale was derived from a study by Green, Levine, & Deeds (1975). The 4-item MMAS was originally found to have a correlation coefficient of 0.61, which is not surprising considering nonadherence factors for medications is often multifactorial (Morisky et al., 1986). The predictive validity of the 4-item MMAS was found to have a linear relationship. Respondents that indicated high adherence based on the MMAS were significantly more likely to have controlled blood pressure compared to those who scored low on the 4-item MMAS ($r=0.58$; $P<0.01$; Morisky et al., 1986). While the 4-item MMAS has been shown to highly correlate with adherence rates, it is suggested that four items are too few to capture the complexity of nonadherence; thus, the 4-item MMAS is to be used in the clinical setting and the 8-item MMAS be used for research purposes (Morisky & DiMatteo, 2011).

The 4-item MMAS has been utilized to measure medication adherence in T2DM (Krapek et al., 2004). A statistically ($p=0.0003$) and clinically significant relationship was measured between Morisky scores and HbA1c (a marker of long-term control), as those with good adherence (Morisky score ≥ 3) had a 10% lower HbA1c (8.67% vs. 7.74%) compared to those with poor adherence (Morisky score ≤ 2; Krapek et al., 2004). In a separate study of patients with T2DM, the 8-item MMAS was found to have moderate internal consistency and excellent test-retest reliability. A statistically significant relationship was measured between the 8-item MMAS and HbA1C (Lee et al., 2013). See Appendix 3 for a list of the questions in the 8-item MMAS.

Several scales have been created over the past decades to measure guideline adherence to self-care activities (Bradely, 1994). The Summary of Diabetes Self-Care Activities (Toobert, Hampson, & Glasgow, 2000) is an 11-item (revised from an original 25-item) survey tool that measures adherence to diet, exercise, SMBG, smoking, and foot care. In a comprehensive review of 7 studies, Toobert et al. (2000) suggested that the SDSCA had adequate test-retest and internal reliability, and had evidence to support its validity and sensitivity to change. Toobert et al. (2000) revised the initial 25-item scale down to the 11-item scale due to the following:

1) consistency in mean values across studies;

2) sufficient variability and lack of ceiling or floor effects;

3) temporal stability;

4) internal consistency;

5) predictive validity;

6) sensitivity to change;

7) ease of scoring; and

8) ease of interpretation.

Additionally, items were added to measure smoking and foot care, and items measuring medication management were eliminated due to ceiling effects and lack of variability in responses from subjects.

Because it is recognized that different factors of self-care do not highly correlate (i.e. an individual may be highly adherent to a diabetes-specific diet, but does not exercise; Orme & Binik, 1989), scores for the self-care activities in the SDSCA are scored individually. The SDSCA limits recall bias by asking respondents to remember how many days out of the last 7 they followed specific clinical recommendations. Thus, the SDSCA is not a long-term marker of adherence per se, but estimates adherence to self-care standards based on self-care during the previous week. See Appendix 4 for questions in the SDSCA.

Self-Efficacy

Conceptual Definition

For this study, self-efficacy was one's beliefs that he or she was able to perform the necessary tasks associated with diabetes self-care.

Operational Definition

Diabetes self-efficacy was tested using the Diabetes Empowerment Scale-Short Form (DES-SF; Anderson, Fitzgerald, Gruppen, Funnell, & Oh, 2003). The DES-SF is an 8-item questionnaire that was condensed from the 28-item Diabetes Empowerment

Scale (DES; Anderson, Funnell, Fitzgerald, & Marrero, 2000). Internal reliability of the DES-SF was found to be acceptable (α= 0.85) using the data from the sample originally used to create the DES, and was found to be acceptable (α= 0.84) in an additional study of 229 subjects (Anderson et al., 2003). Initial measures of content validity appear positive as higher DES-SF scores (higher self-efficacy) was associated with lower HbA1C. However, changes in the DES-SF and HbA1C were not significant correlated after a 6-week intervention (Anderson, Funnell, Nwankwo, Gillard, Fitzgerald, & Oh, 2001).

The DES-SF has 8 questions with Likert-type responses from 1 (strongly disagree) to 5 (strongly agree). The score is obtained by adding the scores from the items and then dividing by the number of completed items leading to a range of possible scores from 1 to 5. The DES-SF takes approximately 5 minutes to complete. See Appendix 5 for the questions in the DES-SF.

Demographic Characteristics and Additional Variables Measured

Demographic data collected consisted of: age, gender, duration of diabetes, relationship status, household income, and education. Additional variables collected included: prior visit with a Certified Diabetes Educator (CDE), hemoglobin A1C, height, weight, current insulin and oral diabetes medication use status, and history of side effects and side effect severity.

The data was defined operationally as follows:

Age

Age was collected by self-report, and recorded in years.

Gender

Gender was collected by self-report, and recorded as male or female.

Duration of Diabetes

Duration of diabetes was collected by self-report, and was collected by having subjects report age at T2DM diagnosis.

Relationship Status

Relationship status was collected by self-report. Relationship status was recorded for the following categories: single, married, divorced, widowed, or committed relationship (unmarried).

Annual Household Income

Annual household income was collected by self-report. Annual household income was recorded for the following categories:

less than $10000

$10000-$19999

$20000-$29999

$30000-$39999

$40000-$49999

$50000-$59999

$60000-$69999

$70000-$79999

$80000-$89999

$90000-$99999

$100,000-$109,999

$110,000-$119,999

$120,000-$129,999

$130,000-$139,999

$140,000-$149,999

greater than or equal to $150,000

Education

Education was collected by self-report. Education was reported for the following categories: less than high school; high school graduate or GED; some college, community, or technical school; community or technical school graduate; college graduate, master's degree, doctoral degree.

Prior Visit with a CDE

Prior visit with a CDE was collected by self-report. Prior visit with a CDE was reported as yes or no.

Hemoglobin A1C

Hemoglobin A1C (A1C) was collected by self-report. The most recent date and level for Hemoglobin A1C was recorded.

Height

Height was collected by self-report, and recorded in feet and inches.

Weight

Weight was collected by self-report, and recorded in pounds.

Current Insulin Use

Current insulin use was collected by self-report, and was recorded as yes or no.

Current Oral Diabetes Medication Use

Current oral diabetes medication use was collected by self-report, and was recorded as yes or no.

Side Effect History

Side effect history was collected by self-report, and was recorded as history in the past 5 years as yes, no, or unsure for “all medications”, and will be recorded for “diabetes-specific medications” as yes, no, or unsure if caused be diabetes medications.

Overall Side Effect Severity

Overall side effect severity was collected by self-report, and was recorded for the previous 5-year span as not sure, mild, moderate, or severe.

Diabetes Medication Side Effect Severity

Diabetes medication side effect severity was collected by self-report, and was recorded for the previous 5-year span as not sure, mild, moderate, or severe.

Procedure

This study was conducted using survey methods. The foremost purpose of the study was to address the perceptions of risk and its relationship with self-care adherence in those with T2DM.

To be included in the data set, respondents had to meet the following criteria: 1) age $\geq$ 21 years, 2) diagnosis of T2DM for at least 1 year, 3) the ability to read, write, and understand English, 4) the ability to make personal medical decisions, and 5) and receiving care at an Essentia Health facility. Because the literature suggests that adherence to medicines in chronic conditions decreases after six months to a more consistent long-term rate (Osterberg & Blaschke, 2005) and A1C is an indicator of blood glucose control over the previous three months, participants must have an existing T2DM diagnosis for at least one year prior to study inclusion. The sample excluded pregnant women, justified as the additional institutional review board requirements needed to include pregnant women were deemed too burdensome for the purposes of this study.

After institutional review board approval was obtained from both the University of Minnesota and Essentia Health, subjects meeting inclusion criteria were identified and emailed a Qualtrics survey link. The surveys were used to collect empirical data on treatment adherence, harm and benefit perception, perceived threat of T2DM, diabetes knowledge, self-efficacy, and demographic variables. The data collected rendered descriptive statistics as well as logistic coefficients that help to identify statistically significant ($p < .05$) relationships between risk perception, other independent variables, and adherence.

The time to complete the survey was estimated to be less than 20 minutes. To maintain confidentiality, subject identifiers were not included on the surveys. All completed surveys were electronically submitted directly to a Qualtrics account under the control of the Essentia Institute of Rural Health. All data was kept in a password secured electronic database maintained by the investigator. All data was analyzed using Statistical Package for Social Sciences version 20 (IBM, 2011).

An approach to calculating sample sizes for logistic regression has not reached consensus (Demidenko, 2007). Green (1991) asserts that a rule-of-thumb equation of the form $N \geq A+Bm$ (where A is a constant related to effect size, B is a minimum ratio of subjects-to-predictors, and *m* is equal to the number of predictors) shows a degree of agreement with actual power analysis results and is useful for research using typical effect sizes, an alpha of 0.05 and a power of 0.80. A form of the above equation, $N > 50 + 8m$ (Green, 1991), was used to predict sample size, and because the outcome is binary (adherent or nonadherent) N was multiplied by the expected proportion of events (Motulsky, 2010, p. 371).

To estimate sample size four predictor variables (harm perception, benefit perception, perceived threat, and self-efficacy) was used. Additional demographic variables were used as control factors in the logistic regression models. As adherence to chronic medications for diabetes is estimated to be near 75% (Rubin, 2005), N from the above equation was multiplied by 4 (Motulsky, 2010). Thus, the estimated number of required participants is 328 (N>4*[50+8*4])

CHAPTER 4: RESULTS

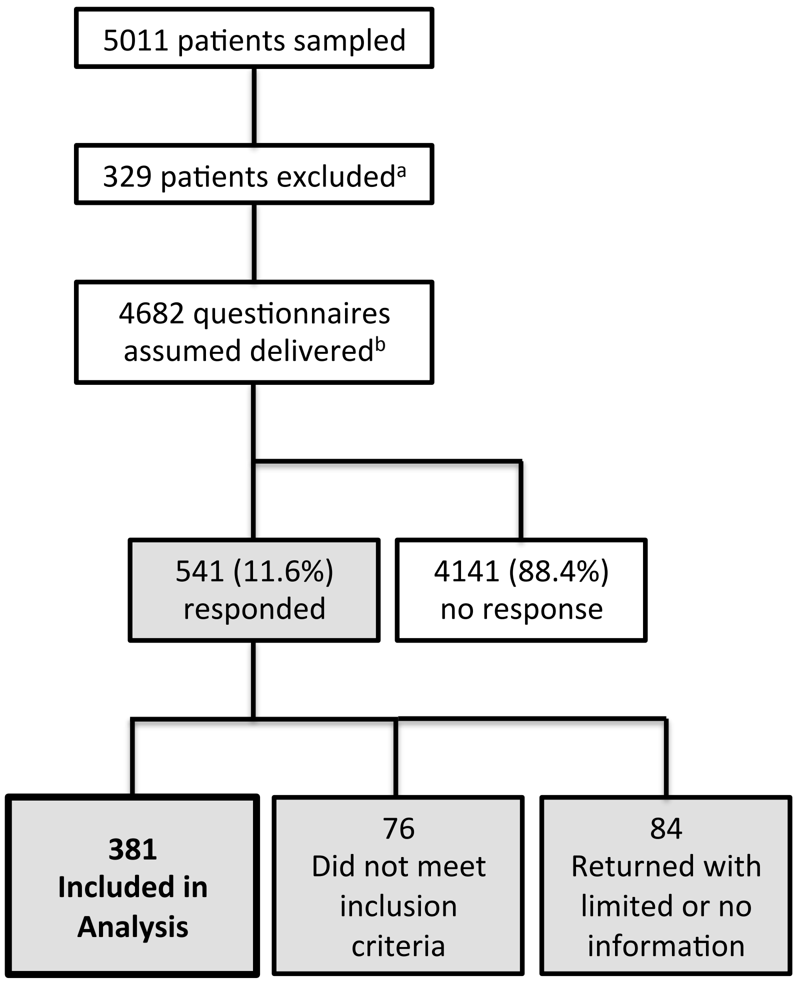
Analysis of data was preceded by searching for outliers and improbable values. This was achieved both by viewing descriptive statistics and frequencies and by visually examining for missing data. Missing data were random without any identifiable pattern. Cases not meeting inclusion criteria (e.g., age < 21 years, no T2DM diagnosis) were removed. Listwise exclusion of cases was used in analyses. The purpose of this explanatory, descriptive analysis is to address the perceptions of risk and its relationship with self-care adherence in those with type 2 diabetes mellitus.

Sample

The explanatory, descriptive study was based on 381 subjects who had received T2DM care within the previous three years at an Essentia Health facility and had an email address on file. A total of 5011 surveys were initially emailed out and 4682 emails reached an email inbox (318 emails were returned as being not true email addresses; unable to account for spam or junk email automated responses). Of the 4682 emails that reached an email inbox there were 541 returned surveys for a return rate of 11.6% (541/4682). After eliminating surveys that were returned blank or with an obvious intention to not continue with the survey there were 430 completed surveys for a response rate of 9.2% (430/4682). After eliminating surveys that did not meeting inclusion criteria (e.g. diagnosis of T1DM, duration of T2DM >=1 year) the final sample size was 381 (8.1%). Please see Figure 3.

Characteristics of the sample (Table 1) included a mean age of 60.4 years (range 28-89), with nearly equal numbers of men and women (n=195 and 183, respectively). A majority of subjects were married (70.5%), had some amount of post high school education (87.2%), and had an annual household income of greater than $60,000 (51%). Most subjects (80.7%) responded that they had visited with a certified

Figure 3. Response Flow Chart



[a] mailer-daemon/admin responses
[b] unable to account for SPAM/Junk mail automated responses

diabetes educator in the past, and 40.2% of subjects have been diagnosed with T2DM for less than 5 years. Greater than half of the subjects (59%) had controlled T2DM (HbA1C<=7.0%) with a mean length of time since last HbA1C test of 87 (SD=88) days.

Table 1: Sample Characteristics

		N	%
Age	M=60.4 (SD=11.2)		
	Range: 28-89		
	<39	19	5.0
	40-59	148	38.8
	>60	214	56.2
Gender	Male	195	51.2
	Female	183	48
Relationship Status	Single	43	11.3
	Married	268	70.5
	Divorced	30	7.9
	Separated	5	1.3
	Widowed	21	5.5
	Committed relationship (unmarried)	13	3.5
Educational Level	Less than high school	4	1.1
	High school graduate or GED	44	11.7
	Some college, community, or technical school	91	24.2
	Community or technical school graduate	69	18.4
	College graduate	107	28.5
	Masters degree	51	13.6
	Doctoral degree	10	2.7
Annual Household Income	<$30,000	77	20.2
	$30,000-$59,999	110	28.9
	$60,000-$89,999	97	25.5
	>=$90,000	97	25.5
T2DM Duration	M=8.9 years (SD=8.4)		
	Range: 1-49		
	<5 years	153	40.2
	5-10 years	100	26.2
	>10 years	128	33.6
BMI	M=33.9 (SD=7.4)		
	Range:18.6-77.1		
HbA1C	M=6.9 (SD=1.2)		
	Range: 5.1-13.0		
	<7%	156	59
	>=7%	108	41
Prior Visit with Certified Diabetes Educator	Yes	305	80.7
	No	51	13.5
	Unsure	22	5.8

Oral DM Med Use	Yes	282	74.0
	No	99	26.0
Insulin Use	Yes	114	29.9
	No	267	70.1
History of DM Med Side Effects	Yes	76	27
	No	165	58.5
	Unsure	41	14.5
DM Med Side Effect History	Mild	29	38
	Moderate	37	48.7
	Severe	10	13.2
History of Med Side Effects	Yes	183	48.4
	No	195	51.6
Medication Side Effect Severity	Mild	80	44.0
	Moderate	69	37.9
	Severe	33	18.1

Perceived Threat Appraisal

Perceived threat of diabetes was calculated as a summated score of the Perceived Threat Subscale of the Cognitive Appraisal of Health Scale. The scale had a possible range of scores between 5-25 with perceived threat of diabetes increasing with score. Respondents reported a minimum of 5 with a maximum of 24, a mean of 14.2 (SD=4.6), and a median of 15. Using mean score as a cutoff, it was observed that 49.9% of subjects considered themselves to have a lower perceived threat of diabetes, while 50.1% of subjects had a higher perceived threat. The Cronbach's alpha for this scale in this sample was 0.859. All 381 subjects completed the scale.

Self-Efficacy

Diabetes self-efficacy was tested using the Diabetes Empowerment Scale-Short Form. The scale is scored on a 1 to 5 scale calculated as an average of the responses to 8 questions with a higher score indicating higher self-efficacy. In this study it was observed that the subjects reported a minimum of 1 with a maximum of 5, a mean of 3.8 (SD=0.61) and a median of 3.88. Using mean score as a cutoff, it was observed that 42% of subjects considered themselves to have a lower self-efficacy for taking care of their T2DM, while 57.7% of subjects had a higher self-efficacy. One subject (0.3%) did not answer the questions for this scale. The Cronbach's alpha for this scale in this sample was 0.814, and 380/381 subjects completed the scale.

Aim 1: Quantitative Description of Risk Perception

Risk perception was measured by having respondents rate the risk of 44 items comprised of 24 drug items, 6 medical procedures, tests, or device items, and 14 nonmedical hazard items (see Appendix 1). Risk perception (perceived benefit minus perceived harm) was measured by asking subjects to separately judge possible harm and benefits of all items on a semantic differential rating scale from 1 (They are not at risk; Not at all beneficial) to 7 (They are very much at risk; Very beneficial). The harm and benefit scores all ranged from 1 to 7. Of the 88 total questions—each of the 44 items were asked twice: once for benefit and once for harm—no item was answered by everyone. The mean number of respondents per item was 376 (98.7%) with a range of 370 to 379 (97.1% to 99.4%).

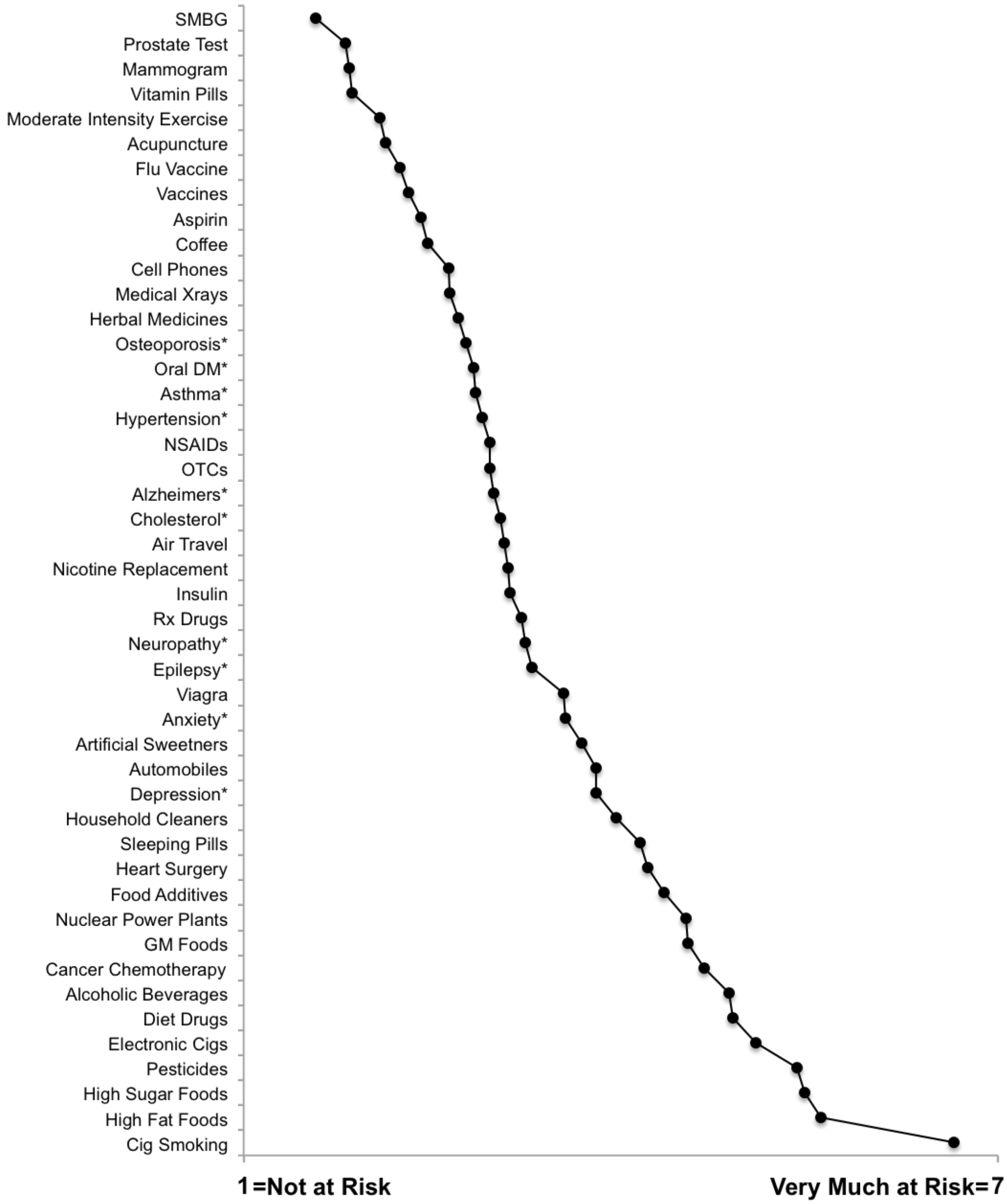
The mean harm perceptions of the 44 items can be found in Figure 4. An item farther from the y-axis (closer to 7) was perceived to have more risk for those that come into contact with it. Questions were asked on a semantic differential scale, with no numbers indicating possible responses between 1 to 7. Therefore, the x-axis of Figure 4 is not labeled at integer intervals. The items deemed to present the lowest level of potential harm were self-monitoring of blood glucose, prostate tests, mammograms, vitamin pills, and moderate intensity exercise. Cigarette smoking, high fat foods, high sugar food, pesticides, and electronic cigarettes were rated as having the highest potential for harm for those that come into contact with the object/activity.

Mean benefit perceptions can be found in Figure 5. An item farther from the y-axis (closer to 7) was deemed to be more beneficial to those who come into contact with it. The items perceived to have the lowest level of benefit were cigarette smoking, electronic cigarettes, high sugar foods, high fat foods, and genetically modified foods. Self-monitoring of blood glucose, heart surgery, insulin, mammograms, and medical x-rays were considered to provide the highest level of benefit.

As noted earlier, risk perception was defined as perceived benefits minus perceived harms. The differences in risk perception of all items rated are presented in Figure 6. Items with scores less than zero were perceived to have more harm than benefit. Items with scores above zero were perceived to have more benefit than harm.

Another representation of risk perception is presented in Figure 7. Harm and benefit were placed on the x-and-y-axis, respectively, creating four harm/benefit quadrants: low harm-low benefit; low harm-high benefit; high harm-high benefit; and high harm-low benefit. Most of the pharmaceutical items are found in the low harm, high benefit quadrant, while cigarette smoking, high sugar foods, and high fat foods are found in the high harm, low benefit quadrant.

Figure 4. Harm Perception Mean Ratings by Respondents Who Have Type 2 Diabetes (n for each item = 370-379)[1,*]



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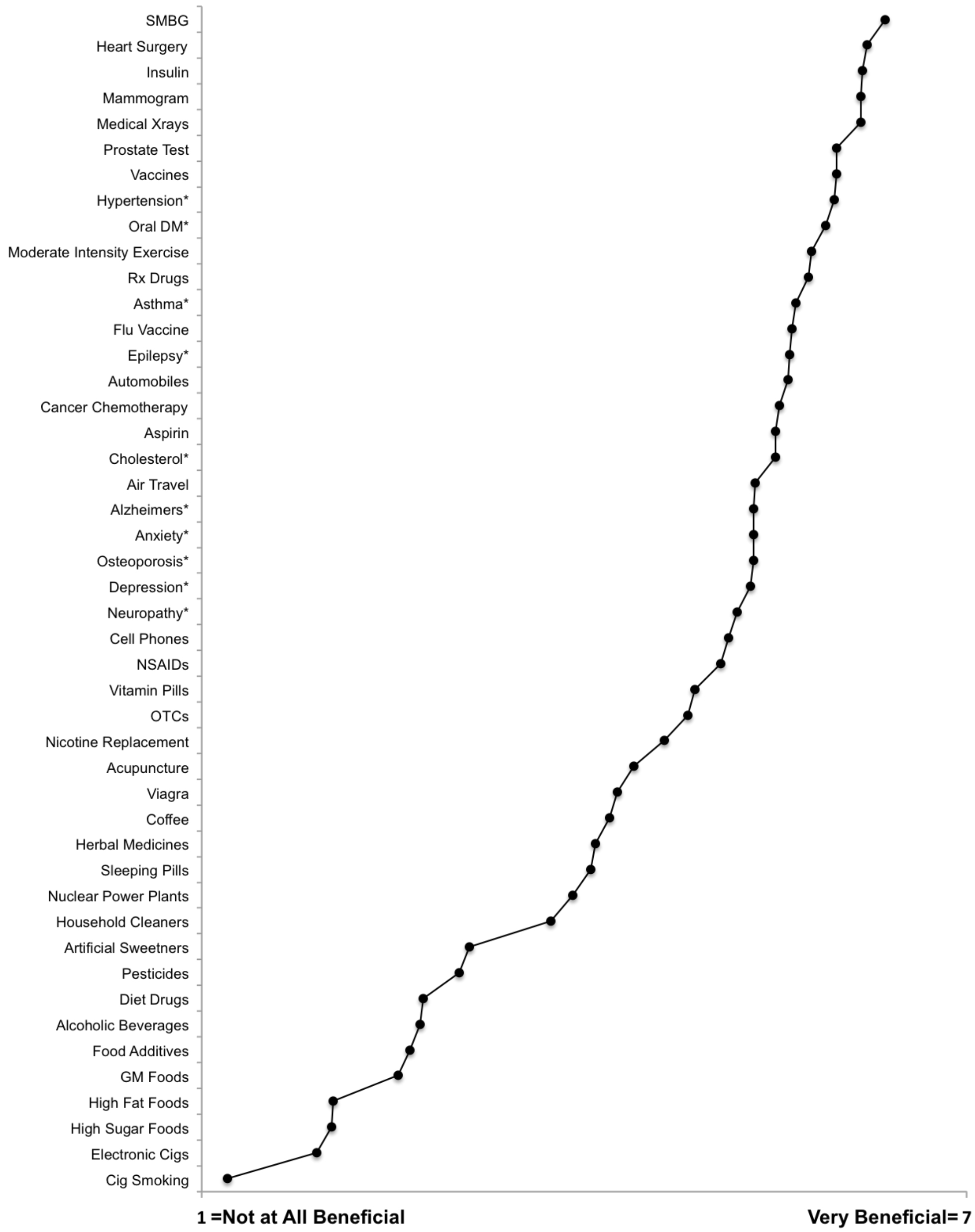
1. Questions were asked on a semantic differential scale, with no numbers indicating possible responses between 1 and 7. Therefore, the x-axis of Figure 4 is not labeled at integer intervals.

- Indicates a drug product indicated to treat the labeled condition.

Figure 5. Benefit Perception Mean Ratings by Respondents Who Have Type 2 Diabetes (n for each item = 370-379)[1,*]



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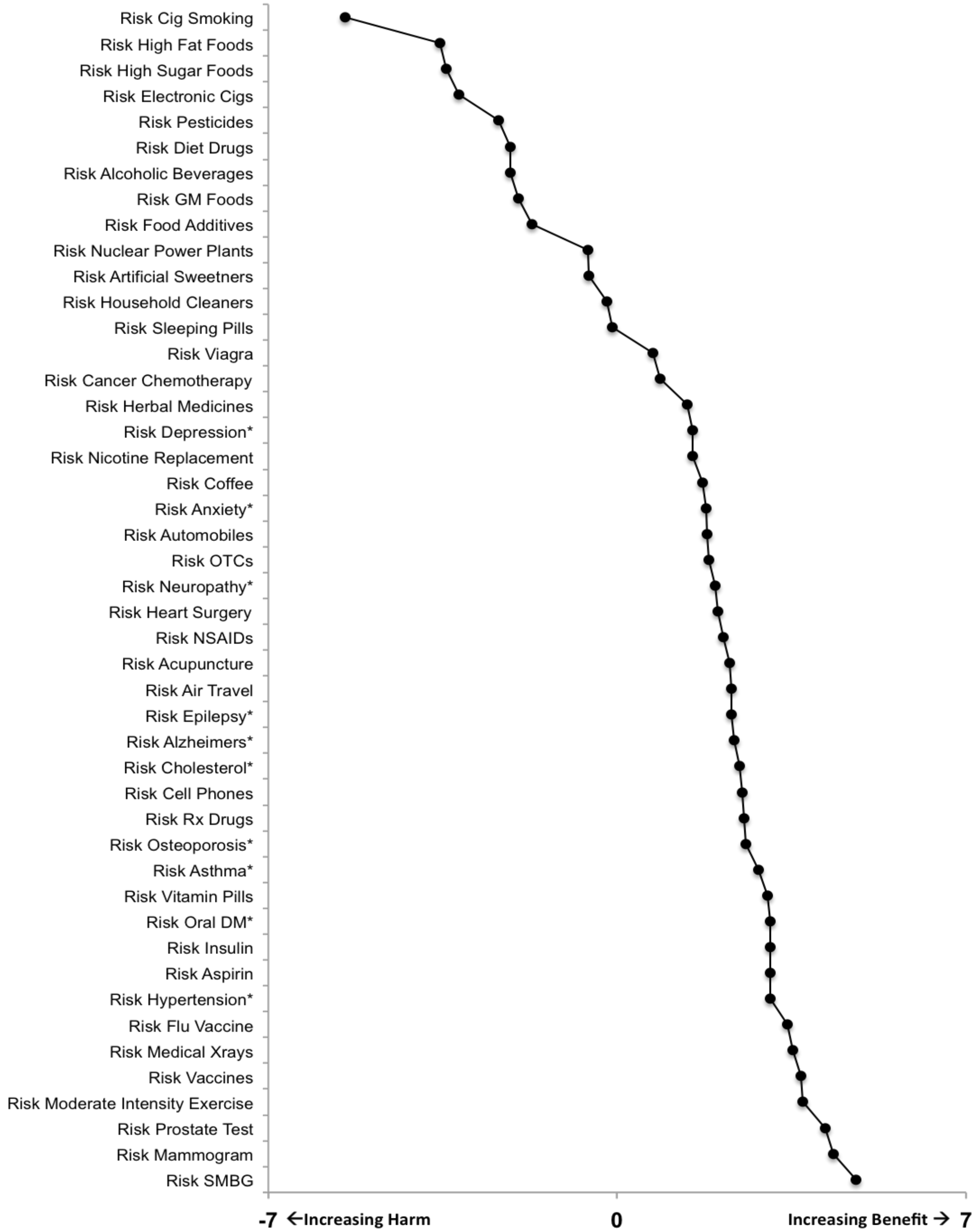
1. Questions were asked on a semantic differential scale, with no numbers indicating possible responses between 1 and 7. Therefore, the x-axis of Figure 5 is not labeled at integer intervals.

- Indicates a drug product indicated to treat the labeled condition.

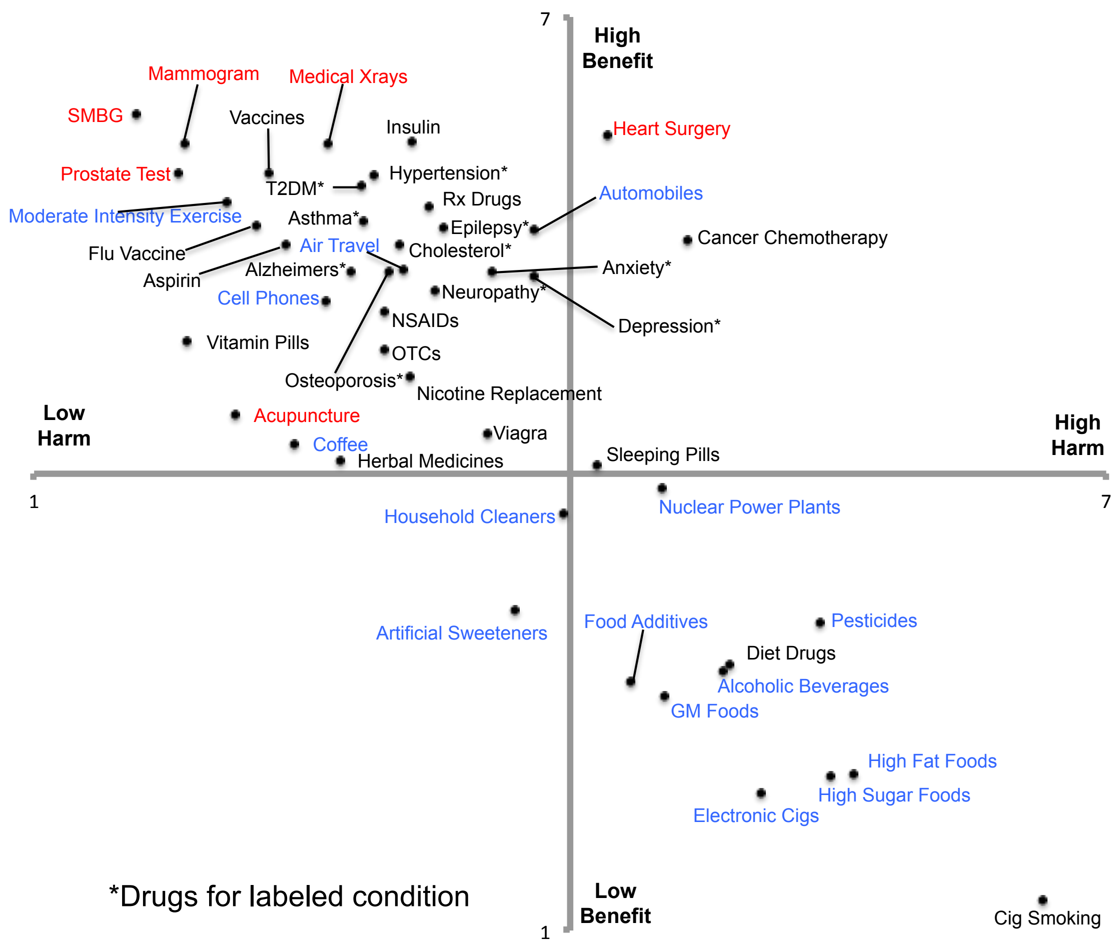
Figure 6. Calculated Risk Perception Ratings (Benefit minus Harm) by Respondents Who Have Type 2 Diabetes (n for each item = 370-379)[1,*]



1. Questions were asked on a semantic differential scale, with no numbers indicating possible responses between 1 and 7. Therefore, the x-axis of Figure 6 is not labeled at integer intervals.

* Indicates a drug product indicated to treat the labeled condition.

Figure 7. Plot of Mean Benefit and Harm Perception by Respondents Who Have Type 2 Diabetes (n for each item = 370-379)



Black= Pharmaceutical Products; Red=Medical Hazards; Blue= Nonmedical Hazards

Risk Perception Differences by Age

Comparisons were made between those who were 60-years/old and younger with those who were older than 60 years of age. Due to the density of the data points, the charts were separated into three separate charts that highlight differences in (1) pharmaceutical products, (2) nonmedical hazards, and (3) medical procedures, tests, and devices. The comparisons can be found in Figures 8, 9, and 10. Because of the density of pharmaceutical products in the "High Benefit-Low Harm" quadrant, only select products were included in Figure 10. Pairwise differences between harm, benefit, and risk perceptions are compared in Table 2 for respondents younger or equal to 60 years of age and those older than 60 years old. As highlighted in Table 2, statistical differences were only seen with four items (GM Foods, Heart Surgery, Herbal Medicines, and Artificial Sweeteners).

Pairwise comparisons between individual groups used Mann-Whitney U with multiplicity controlled for by using the Šidák multitest correction to keep the experimentwise error rate at $\alpha<0.05$ (Abdi, 2007). Abdi (2007) describes the Šidák calculation as follows:

> 1) $\text{alphaPC} = 1.0 - (1.0 - \text{alphaFW})^{1/k}$
> Where alphaPC is the per comparison alpha, alphaFW is the familywise alpha, and k is the number of comparisons.

Table 2. Significantly Different Harm, Benefit, and Risk Perceptions by Respondents Less-Than-or-Equal-to 60 Years Old and Those Greater-Than 60 Years Old

	Age (years)	N	Mean Rank	*z* score	p-value*
Harm Heart Surgery	<=60	185	210.09	-3.629	0.0003
	>60	193	169.76		
Harm GM Foods	<=60	186	210.76	-3.773	0.0002
	>60	192	168.91		
Benefit Artificial Sweeteners	<=60	187	171.1	-3.302	0.00096
	>60	191	207.51		
Risk Herbal Medicines	<=60	183	205.94	-4.091	0.00004
	>60	183	161.06		
Risk Artificial Sweeteners	<=60	185	169.01	-3.372	0.0008
	>60	190	206.49		
Risk GM Foods	<=60	186	186.48	-3.425	0.00062
	>60	189	189.49		

*Šidák Cutoff=0.0011

Figure 8. Plot of Mean Benefit and Harm Perception of Nonmedical Hazards by Respondents Less-Than-or-Equal-to 60 Years Old and Respondents Greater-Than 60 Years Old Who Have Type 2 Diabetes

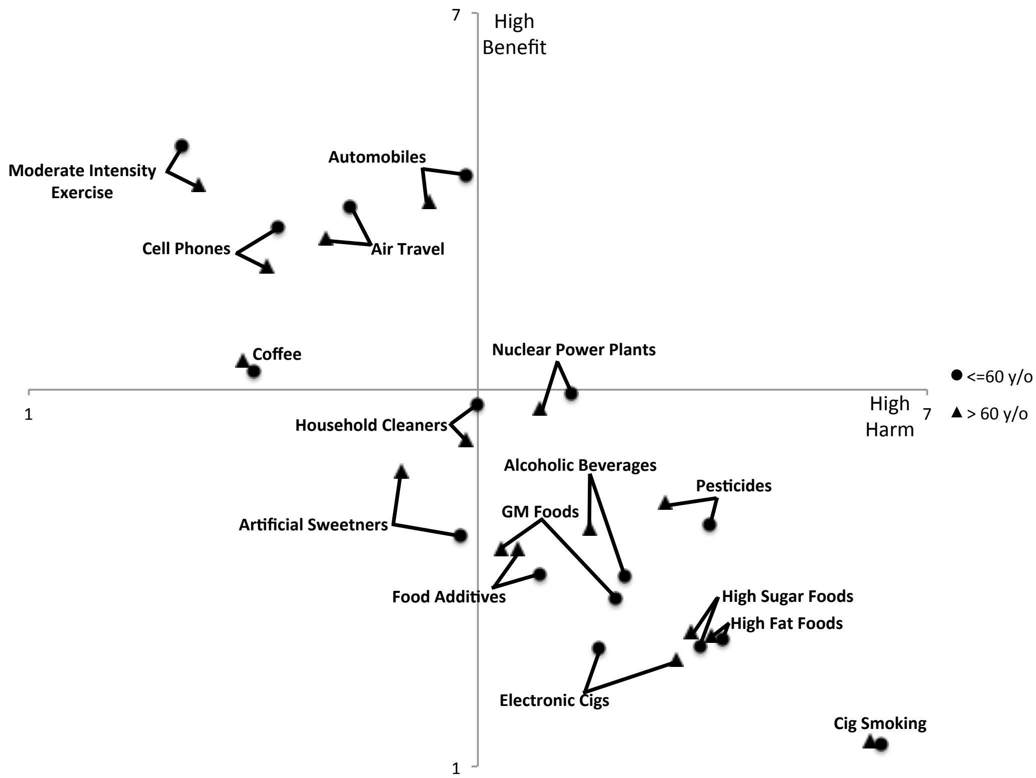
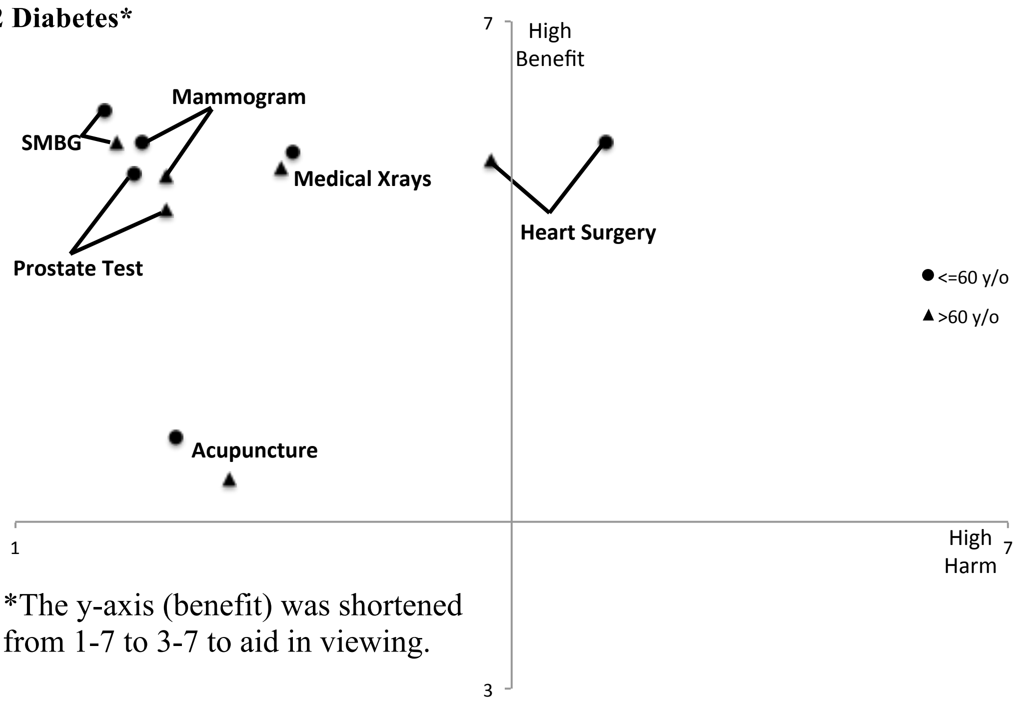
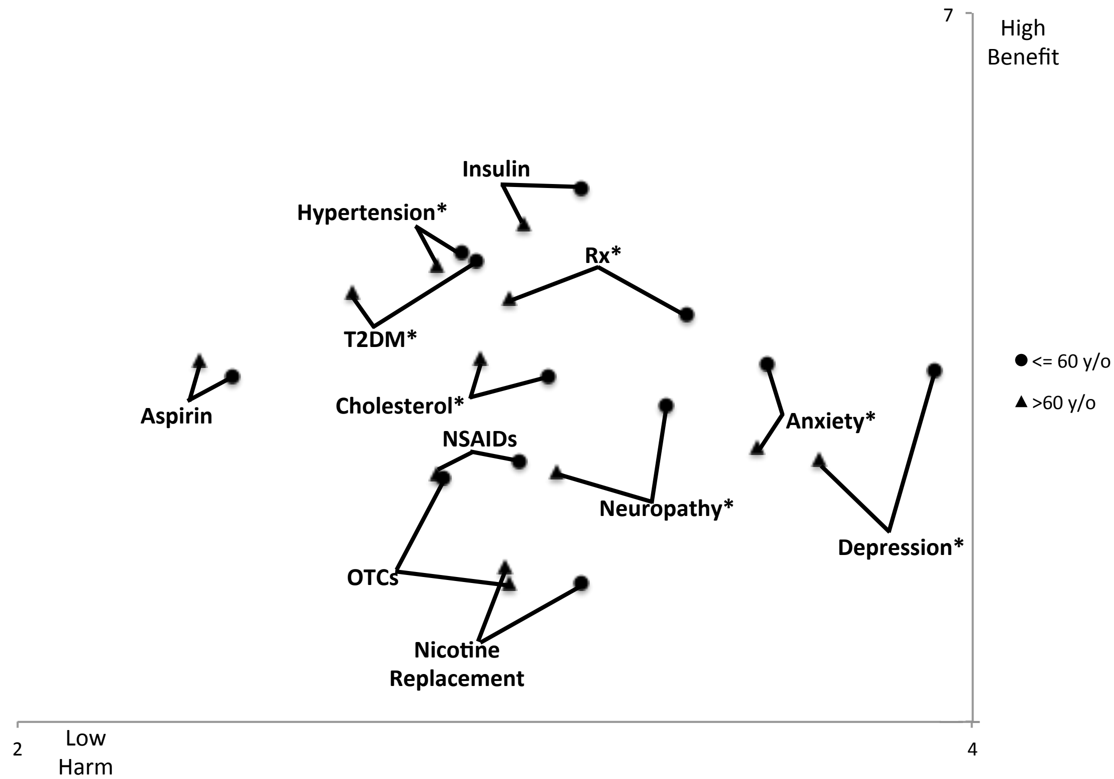


Figure 9. Plot of Mean Benefit and Harm Perception of Medical Hazards by Respondents Less-Than-or-Equal-to 60 Years Old and Those Greater-Than 60 Years Old Who Have Type 2 Diabetes*



*The y-axis (benefit) was shortened from 1-7 to 3-7 to aid in viewing.

Figure 10. Plot of Mean Benefit and Harm Perception of Pharmaceutical Products by Respondents Less-Than-or-Equal-to 60 Years Old and Those Greater-Than 60 Years Old Who Have Type 2 Diabetes****



**The x- (harm) and y- (benefit) axes were shortened to aid in viewing.
*Drugs for listed condition

Risk Perception Differences between Users/Nonusers of Medications

Differences between harm, benefit, and risk perceptions are compared below for respondents using oral T2DM medications vs. respondents not using oral T2DM medications, those using insulin vs. not using insulin, and males vs. females.

As noted in the demographics section, 74% (n=282) of the sample was currently using oral T2DM medications. It was hypothesized that those who are using oral T2DM medications would perceive the threat of those medications differently than those not using these particular medications. Outcomes of the Mann-Whitney U test between oral T2DM medications users and nonusers are presented in Table 3. Statistically significant differences were found for both risk and benefit ratings of oral DM drugs, with respondents who are using these medications perceiving higher net benefit than respondents who were not using these medications.

Table 3. Perception of Oral DM Drugs in Those with Type 2 Diabetes

	Use Oral DM Meds	**N**	**Mean Rank**	***z* score**	**p-value***
Risk Oral DM Drugs	Yes No	275 98	196.15 161.15	-2.782	.005
Benefit Oral DM Drugs	Yes No	278 99	197.29 165.71	-2.617	.009
Harm Oral DM Drugs	Yes No	278 98	184.55 199.70	-1.216	.224

*Šidák Cutoff=0.017

Among the 381 respondents, 114 (29.9%) indicated that they were currently using insulin to help treat T2DM. It was hypothesized that those using insulin to treat diabetes would perceive the threat of insulin differently than those that were not using insulin. Outcomes of the Mann-Whitney U between insulin users vs. nonusers are presented in Table 4. While the p-values for harm insulin and risk of insulin between insulin users and nonusers were <0.05, none of the tests were deemed significant after using the Šidák correction to limit the potential for a Type I error.

Table 4. Perception of Insulin in a Sample of Those with Type 2 Diabetes

	Use Insulin?	N	Mean Rank	*z* score	p-value*
Harm Insulin	Yes No	113 263	169.68 196.59	-2.240	.025
Risk Insulin	Yes No	113 260	204.42 179.43	-2.079	.038
Benefit Insulin	Yes No	113 263	194.81 185.79	-0.808	.419

*Šidák Cutoff=0.017

Risk Perception Differences between Genders

The sample consisted of 51.6% males and 48% females. Mann-Whitney U with a Šidák correction to prevent a Type I error was used to compare differences in perceived threat of drug, medical, and nonmedical hazards. Please see Tables 5 and 6 for a list of statistically significant items. A higher mean rank for *harm* items indicated more perceived harm and a higher mean rank for *benefit* items indicates a higher perceived benefit. Of note, the perception of the benefits of oral DM medications, neuropathy medications, and self-monitoring of blood glucose was significantly greater in females than males.

Table 5. Significantly Different Harm Perceptions between Men and Women in a Sample of Those with Type 2 Diabetes

	Gender	N	Mean Rank	*z* score	p-value*
Harm GM Foods	Female Male	182 193	214.29 163.21	-4.623	<0.00001
Harm Nuclear Power Plants	Female Male	183 193	218.47 160.08	-5.283	<0.00001
Harm Air Travel	Female Male	183 193	207.6 170.39	-3.390	0.000100

*Šidák Cutoff=0.0011

Table 6. Significantly Different Benefit Perceptions between Men and Women in a Sample of Those with Type 2 Diabetes

	Gender	N	Mean Rank	*z* score	p-value*
Benefit GM Foods	Female	181	162.38	-4.519	0.00001
	Male	193	211.06		
Benefit Nuclear Power Plants	Female	181	165.65	-3.840	0.000123
	Male	193	207.99		
Benefit Oral DM Drugs	Female	182	208.12	-3.794	0.000148
	Male	192	167.96		
Benefit Neuropathy	Female	182	206.98	-3.580	0.000344
	Male	191	167.96		
Benefit SMBG	Female	182	204.76	-3.496	0.000472
	Male	192	171.14		
Benefit Epilepsy	Female	178	203.7	-3.410	0.00065
	Male	191	167.57		
Acupuncture	Female	178	203.31	-3.351	0.0008
	Male	190	166.88		

*Šidák Cutoff=0.0011

Risk perception and Side Effects

Respondents were asked if they had experienced side effects to diabetes medications or other prescription medications over the previous 5 years. Regarding T2DM medications specifically, 101 (26.7%) reported having experienced side effects related to diabetes medications, 227 (60.1%) denied having experienced side effects, and 50 (13.2%) were unsure. Respondents indicating that they were unsure if they have suffered any prescription medication side effects were excluded from the following analysis.

Data were filtered to allow for analysis of respondents who were currently taking an oral DM drug. A Mann-Whitney U test comparing respondents who had experienced T2DM medication-related side effects and those who had not was performed, comparing differences in Morisky scores and in perceptions of harm, benefit, and risk of oral DM drugs. A statistical difference was noted in perceived harm and perceived risk of oral DM drugs, but not in perceived benefit or the 8-Item Morisky Medication Adherence Scale. See Table 7 for relevant p-values. A subsequent Kruskal-Wallis One-Way Analysis of Variance was performed to test for differences between three groups separated by severity levels of side effects (mild, moderate, and severe) with the same independent variables. This test yielded no statistically significant differences.

Table 7. Perception of Oral DM Drugs in Those Taking an Oral DM Drug between Those who Have Experienced versus Have Not Experienced Side Effects

	DM Med Side Effects?	N	Mean Rank	*z* score	p-value*
Harm Oral DM Drugs	Yes No	75 164	148.39 107.02	-4.427	.000
Risk Oral DM Drugs	Yes No	75 161	94.7 129.59	-3.715	.000
Morisky	Yes No	76 165	104.94 128.40	-2.475	.013
Benefit Oral DM Drugs	Yes No	76 162	115.78 121.25	-.613	.540

*Šidák Cutoff=0.0127

A Mann-Whitney U test was performed among those respondents who indicated that they were currently using insulin (no =53; yes =43). No statistical differences ($p>0.05$) were found between the two groups when comparing Morisky scores, perceived harm, benefit, or risk of insulin.

After filtering the data for only respondents who were either taking insulin or oral DM medications, a Mann-Whitney U test was conducted to compare Morisky scores, perceived harm, benefit, and risk of prescription drugs in respondents who had experienced vs. had not experienced side effects. Statistically significant differences were seen between these two groups regarding perceived harm and perceived risk of prescription drugs. See Table 8.

Table 8. Perception of RX Drugs in Those Taking either an Oral DM Drug or Insulin between Those who Have Experienced versus Have Not Experienced Side Effects

	Med Side Effects?	N	Mean Rank	*z* score	p-value*
Harm Rx Drugs	Yes No	183 194	210.61 168.61	-3.834	.000
Risk Rx Drugs	Yes No	183 190	168.48 204.84	-3.290	.001
Benefit Rx Drugs	Yes No	183 191	180.66 194.05	-1.249	.211

*Šidák Cutoff=0.017

A subsequent Kruskal-Wallis One –Way Analysis of Variance (see Table 9) performed to test for differences between three groups separated by severity levels of side effects (mild, moderate, and severe) with the same independent variables revealed statistical differences in perceived harm and perceived risk of prescription drugs.

Table 9. Perception of RX Drugs in Those Taking either an Oral DM Drug or Insulin between Severity of Side Effects

	Med Side Effects?	N	Mean Rank	X^2	p-value*
Harm Rx Drugs	Mild Moderate Severe	80 69 33	78.54 96.39 112.70	11.382	.003
Risk Rx Drugs	Mild Moderate Severe	80 69 33	105.70 84.98 70.71	12.278	.002
Benefit Rx Drugs	Mild Moderate Severe	80 69 33	99.91 86.84 80.86	4.235	.120

*Šidák Cutoff=0.017

Aim 2: Adherence to Diabetes Treatments

Adherence to Diabetes Medications

Adherence to diabetes medications was measured using the Morisky Scale, and scored on a range of 0-8 with a higher score representing higher adherence. Because some Morisky items specifically inquire about oral medication use, the sample was filtered to only include oral DM medication users prior to analyzing the Morisky scale. The subjects recorded scores ranging from a minimum of 1.25 to a maximum of 8 with a mean of 6.34 (SD=1.55) and a median of 7. After segmenting scores into adherence categories 34% of respondents had low adherence (0-5.9), 40.1% had medium adherence 6-7.9), and 25.9% had high adherence (8). The eight items of the Morisky scale had a Cronbach's alpha of 0.6. All 282 respondents who indicated current oral DM medication use completed the Morisky items.

Adherence to Exercise

Adherence to exercise was measured using two questions found in the Summary of Diabetes Self-Care Activities (SDSCA). The respondents' minimum number of days participating in a specific exercise session for at least 30 minutes ranged from 0 days to a maximum of 7 days, with a mean of 2.78 (SD=2.18) days. Nearly 1 out of 5 respondents (18.3%) indicated that they had not participated in any exercise in the previous 7 days, while nearly a similar percentage (22.3%) exercised at least 5 of the previous 7 days. The exercise questions found in the SDSCA had a Cronbach's alpha of 0.837.

Adherence to Diet

Adherence to diet was measured using 4 questions found in the SDSCA (Exhibit X). For the general diet questions respondents reported a minimum of 0 days and a maximum of 7 days, with a mean of 4.55 (SD=1.83) days. Almost a quarter of subjects (22.7%) indicated that they followed a healthy eating plan 3 or less days per week. The Cronbach's alpha for the General Diet questions was 0.923.

Adherence to specific diet had two questions that asked about fruit and vegetable consumption and high-fat food consumption over the previous 7 days. The specific diet question regarding high-fat foods was reverse-coded prior to analysis. For the specific diet questions the respondents reported a minimum of 0 days with a maximum of 7 days and a mean of 3.83 (SD=1.56) days. The Cronbach's alpha for the Specific Diet questions was 0.269.

Adherence to Foot Care

Adherence to foot care was measured using two questions found in the SDSCA that ask about checking feet and inspecting the inside of shoes. The respondents reported a minimum of 0 and a maximum of 7 days with a mean of 3.12 (SD=2.32) days and a median of 3.5 days. The Cronbach's alpha for the foot care questions was 0.646.

Adherence to Self-Monitoring of Blood Glucose

Adherence to blood glucose monitoring was measured using two questions found in the SDSCA. The respondents reported a minimum of 0 and a maximum of 7 days with a mean of 3.90 (SD=2.73) days and a median of 4 days. More than 1 in 4 respondents (27.8%) tested their blood glucose on a daily basis, while 18.9% indicated that they did not test once during the previous 7 days. The Cronbach's alpha for the two blood glucose monitoring questions was 0.807.

Cigarette Smoking

The SDSCA only asks about tobacco use in the form of cigarette smoking. A majority of individuals (88.7%) had not smoked a cigarette in the previous 7 days, while 42 individuals (11%) had at least one puff of a cigarette in the previous 7 days. Of those that indicated cigarette usage, the minimum number of cigarettes smoked per day was 0 with a maximum of 30 and a mean of 9.76 (SD=7.44).

Aim 3: Relationship between Risk Perception and Adherence to Diabetes Self-Care Behaviors

Separate regression models were created for adherence to medications, exercise, diet, and self-monitoring of blood glucose by using the Morisky scale for medication adherence and the relevant subscales in the SDSCA for the remaining dependent variables. Prior to analysis, the dependent variables for the separate models and the various independent variables (e.g. sociodemographic factors, threat, diabetes empowerment, and risk perception variables) were examined through IBM SPSS to check for assumptions of multivariate regression analysis, which include linearity of the relationship between the residuals of the independent with the dependent variables, no multicollinearity, homoscedasticity, and normality (Tabachnick & Fidell, 2007).

It was determined that a majority of variables had issues with skewness and kurtosis (generally platy-kurtic). Additional evaluation using bivariate correlation matrices found some small, but significant correlations between dependent and independent variables, but many relationships were non-linear. To adhere to assumptions for normality, linearity, and homoscedasticity many of the independent and dependent variables were transformed using inverse, square root, or log transformations. Subsequent bivariate correlation matrices and Kolmogorov-Smirnov tests were then used to determine adherence to multivariate regression assumptions. Results of this evaluation led to the determination that meeting assumptions for multivariate linear regression was not feasible, and to proceed with binomial logistic regression, which allows for non-normality and non-linearity of data (Tabachnick & Fidell, 2013).

Expected frequencies of the independent variables were checked to ensure variables had no more than 20% of cells with less than 5 values, which caused the variable "education" to be transformed to "college educated" (0=no, 1=yes), and "relationship status" to be transformed to "married" (also included "committed relationship"; 0=no, 1=yes). "History of DM side effects" had yes, no, and unsure as possible responses, which was changed to a dichotomous variable (no=0, yes and unsure=1).

Due to the large number of control variables Pearson χ^2 test for association was utilized to narrow down possible nominal and ordinal controls, while the Pearson's cross-product-moment correlation coefficient was used to narrow down interval and ratio-level control. Independent variables with correlation coefficients of at least $p<0.1$ with respect to dependent variables were used in the respective models. See Table 10 for a list of control variables.

Table 10. Possible Control Variables in Logistic Regression Models

Variable	Name	Variable Labels
Age	Age	
Income	Income	
Threat Scale	Threat	
Diabetes Empowerment Scale	DES	
Time since T2DM Diagnosis	DMDuration	
Gender	Gender	Female=0, Male=1
Education	EduCat	Did not graduate college=0, College graduate=1
History of T2DM medication side effects	DMSideEffects	No=0, Yes/Unsure=1
Relationship	Married	No=0, Yes=1
Saw T2DM Educator	DMEducator	No=0, Yes=1

Medication Adherence Logistic Regression

Because the Morisky scale contains items that specifically inquire about oral medication use, only respondents who indicated current use of prescription oral diabetes medications were included in this analysis (n= 282). The Morisky scale was transformed into two dichotomous groups: Morisky score 0-5.9 (0=nonadherent) and 6-8 (1=adherent), which was used as the dependent variable in the logistic regression analysis.

See Table 11 for the correlations between respondents who were adherent/not adherent to medications and control variables. Results from the correlation indicated that age, threat, and the Diabetes Empowerment Scale (DES) would control for the relationship between adherence/nonadherence to medications and risk perception. Correlation tests failed to find significance between Morisky adherent/nonadherent and harm, benefit; and risk perception variables of "Rx Drugs" and "Oral DM Drugs." Thus, only "Risk Oral DM Drugs" was used in the logistic regression analysis.

Table 11. Correlations between Medication Adherence and Control Variables

Variable	Level of Measurement	Pearson's	r or χ^2	p-value*
Age	Scale	r	.276	.000
Income	Scale	r	-.042	.262
Threat	Scale	r	-.174	.004
DES	Scale	r	.195	.001
DM Duration	Scale	r	.045	.461
Gender	Nominal	χ^2	.586	.444
Education	Nominal	χ^2	.273	.602
DMSideEffects	Nominal	χ^2	1.367	.242
Married	Nominal	χ^2	.004	.952
Saw DM Educator	Nominal	χ^2	.000	1.000

* Correlation coefficients of at least $p<0.1$ were used in the respective model.
Threat=Threat of diabetes; DES=Diabetes Empowerment Scale; DM Duration=Years since T2DM diagnosis; Education= College graduate(1); DMSideEffects=Side effects attributed to T2DM medications in last 5 years; Saw DM Educator=Previously visited with Certified Diabetes Educator

A logistic regression model was estimated using the enter method to explore the relationship between medication adherence and risk perception of oral T2DM medications. The final model is reported in Table 12. The base model (constant) correctly predicted 65.3% of cases, while the full model correctly predicted 69.7% of cases, indicating improvement over the base model. The Omnibus Test of Model Coefficients "goodness of fit" (χ^2=32.811, df=4, p=.000) also indicates improvement of the full model over the base model (Burns & Burns, 2008). The Hosmer and Lemeshow Test (χ^2=7.776, df=8, p=.456) indicates that the full model is a good fit (Tabachnick & Fidell, 2013). The final model, as depicted in Table 12, is Logit (MoriskyAdherence)= 1.050 (Age) + 1.824 (DES).

Table 12.
Logistic Regression to Measure the Association between Medication Adherence and Risk Perception of Oral T2DM Drugs.

							95% CI for Exp(B)	
	B	S.E.	Wald	Df	Sig.	Exp(B)	Lower	Upper
Age	.049	.013	13.433	1	0.000	1.050	1.023	1.078
Threat	-.058	.034	2.961	1	0.085	0.944	0.884	1.008
DES	0.601	0.249	5.831	1	0.016	1.824	1.120	2.972
RP_OralDMDrugs	-0.013	0.073	0.032	1	0.858	0.987	0.856	1.138
Constant	-3.569	1.503	5.639	1	0.018	0.028		
N=274								

Threat=Threat of diabetes; DES=Diabetes Empowerment Scale;
RP_OralDMDrugs=Risk Perception of Oral DM Drugs

The final model revealed a significant correlation between age and adherence to diabetes treatments when controlling for threat, DES, and risk perception of oral DM drugs. Specifically, older patients with T2DM were more likely to be adherent to their diabetes medications than younger patients. A significant correlation was also found between the DES and medication adherence when controlling for threat, age, and risk perception of oral DM. Specifically, respondents who scored a 5 on the DES were nearly 7.3 times more likely to be adherent to diabetes medications than those who scored a 1 on the DES. Risk Perception of Oral T2DM medications was not significantly correlated with medication adherence (χ^2=0.032, p=0.858), as it was not a useful predictor of adherence to medications in the logistic regression model.

Exercise Adherence Logistic Regression

To create two dichotomous groups from the exercise subscale of the Summary of Diabetes Self-Care Activities it was decided to transform SDSCA Exercise into those that exercise 5 or more days per week (1=exercise adherent) and those that exercise less than 5 days per week (0=exercise nonadherent). The decision to dichotomize the exercise subscale in this manner was based on the "Standards of Medical Care in Diabetes—2013" by the American Diabetes Association (ADA, 2013), and this dichotomous variable was used as the dependent variable in the logistic regression analysis.

See Table 13 for the correlations between respondents who were adherent/not adherent to exercise and control variables. Because only those independent variables that had correlation coefficient p-values of less then or equal to 0.1 between respondents who were adherent/not adherent to exercise and their perceptions of harm, benefit, and risk perception of moderate intensity exercise, it was determined to use benefit (*r=.088*, p=.092) and risk (*r*=.102 , p=.048) perception of moderate intensity exercise as independent variables in separate logistic regression analyses.

Table 13. Correlations between Exercise Adherence and Control Variables

Variable	Level of Measurement	Test Statistic	r or χ^2 (df)	p-value*
Age	Scale	r	0.011	0.831
Income	Scale	r	0.189	0.000
Threat	Scale	r	-0.057	0.283
DES	Scale	r	0.183	0.000
DM Duration	Scale	r	-0.083	0.113
Gender	Nominal	χ^2	5.596(1)	0.018
Education	Nominal	χ^2	2.741(1)	0.098
Married	Nominal	χ^2	4.103(1)	0.043
Saw DM Educator	Nominal	χ^2	1.100(1)	0.294

* Correlation coefficients of at least p<0.1 were used in the respective model.
Threat=Threat of diabetes; DES=Diabetes Empowerment Scale; DM Duration=Years since T2DM diagnosis; Education= College graduate (1); Saw DM Educator=Previously visited with Certified Diabetes Educator

A logistic regression model was estimated using the enter method to explore the relationship between exercise adherence and risk perception of moderate intensity exercise. The final model is presented in Table 14. The base model (constant) correctly predicted 77.8% of cases, while the full model correctly predicted 79.8% of cases, which indicates an improvement over the base model. The Omnibus Test of Model Coefficients "goodness of fit" (χ^2=37.302, df=6, p=0.000) also indicates the improvement of the full model of the base model. The Hosmer and Lemeshow Test (χ^2=13.292, df=8, p=0.102) indicates that the full model is a good fit. The final model, as depicted in Table 14, is Logit (Exercise)= 1.084 (Income) + 2.953 (DES).

Table 14. Logistic Regression to Measure the Association between Exercise Adherence and Risk Perception of Moderate Intensity Exercise

							95% CI for Exp(B)	
	B	S.E.	Wald	Df	Sig.	Exp(B)	Lower	Upper
Married (1)	-0.399	0.356	1.252	1	0.263	0.671	0.334	1.349
Education (1)	-0.269	0.290	0.859	1	0.354	0.764	0.433	1.349
Gender (1)	-0.463	0.275	2.834	1	0.092	0.629	0.367	1.079
Income	0.081	0.038	4.584	1	0.032	1.084	1.007	1.167
DES	1.083	0.275	15.556	1	0.000	2.953	1.724	5.057
RP_MIE	0.033	0.068	0.241	1	0.624	1.034	0.905	1.182
Constant	-6.025	1.318	20.886	1	0.000	0.002		
N=356								

DES=Diabetes Empowerment Scale;
RP_MIE=Risk Perception of Moderate Intensity Exercise

The final model revealed a significant correlation between household income and adherence to exercise when controlling for marriage status, education, gender, DES, and risk perception of moderate intensity exercise. Specifically, patients with T2DM who have a higher household income were more likely to exercise 5 or more days per week. The logistic regression model suggests that those who make between $140,000 and $149,999 are 15.176 times more likely to exercise 5 or more times per week compared to those than make less than $10,000 per year. Additionally, the final model revealed a significant correlation between the DES and adherence to exercise when controlling for marriage status, education, gender, income, and risk perception of moderate intensity exercise. Those who scored a 5 on the Diabetes Empowerment Scale were 11.8 times more likely to be adherent to exercise recommendations compared to those who scored a 1 on the DES in the final model. Risk perception of moderate intensity exercise (χ^2=0.241, p=0.624) was not significantly correlated with adherence to exercise. The addition of benefit perception of moderate intensity exercise (in place of risk perception of moderate intensity exercise) did not improve the overall model and was not significantly correlated with adherence to exercise recommendations (χ^2=0.126, p=0.723).

Self-Monitoring Blood Glucose Adherence Logistic Regression

To create two dichotomous groups from the self-monitoring blood glucose (SMBG) subscale of the Summary of Diabetes Self-Care Activities it was decided to transform SDSCA Blood Glucose into respondents who scored a 4 or greater (1=SMBG adherent) and respondents who scored less than 4 on the SMBG subscale (0=SMBG nonadherent), which was used as the dependent variable in the logistic regression analysis. The decision to dichotomize the SMBG subscale in this manner was based on the median value of the subscale (median=4) in the study sample.

See Table 15 for the correlations between control variables and respondents scoring at or above the median and those scoring below the median of the blood glucose subscale of the SDSCA. Because of the respective p-values of the correlation coefficients between respondents who were above/below median of blood glucose subscale of SDSCA and their perceptions of harm, benefit, and risk of self-monitoring of blood glucose, it was determined to use benefit (*r=0.167*, p=0.001) and risk (*r=0.*124 , p=0.017) perception of

SMBG as independent variables in separate logistic regression analyses.

Table 15. Correlations between SMBG Adherence and Control Variables

Variable	Level of Measurement	Test Statistic	r or χ^2 (df)	p-value*
Age	Scale	r	0.111	0.035
Income	Scale	r	-0.036	0.500
Threat	Scale	r	0.051	0.330
DES	Scale	r	0.088	0.095
DM Duration	Scale	r	0.106	0.043
Gender	Nominal	χ^2	0.205(1)	0.651
Education	Nominal	χ^2	7.988(1)	0.005
Married	Nominal	χ^2	1.329(1)	0.249
Saw DM Educator	Nominal	χ^2	3.704(1)	0.054

* Correlation coefficients of at least p<0.1 were used in the respective model.
Threat=Threat of diabetes; DES=Diabetes Empowerment Scale; DM Duration=Years since T2DM diagnosis; Education= College graduate(1); Saw DM Educator=Previously visited with Certified Diabetes Educator

A logistic regression model was estimated using the enter method to explore the relationship between SMBG adherence and risk perception of SMBG. The final model is reported in Table 16. The base model (constant) correctly predicted 51.2% of cases, while the full model correctly predicted 62.1% of cases, which indicates an improvement over the base model. The Omnibus Test of Model Coefficients "goodness of fit" (χ^2=25.021, df=6, p=0.000) also indicates the improvement of the full model of the base model. The Hosmer and Lemeshow Test (χ^2=13.217, df=8, p=0.105) indicates that the full model is a good fit. The final model, as depicted in Table 16, is Logit (SMBG)= 1.955 (Education) + 1.182 (RP_SMBG).

The final model revealed a significant correlation between college graduation and adherence to self-monitoring of blood glucose when controlling for age, DES, duration of T2DM, history of a visit with a certified diabetes educator, and risk perception of SMBG. Specifically, patients with T2DM who have graduated from college were nearly twice as likely (1.955 times) to score a 4 or greater on the self-monitor blood glucose subscale of the SDSCA in the final model.

Table 16. Logistic Regression to Measure the Association between SMBG Adherence and Risk Perception of SMBG

	B	S.E.	Wald	Df	Sig.	Exp(B)	95% CI for Exp(B) Lower	Upper
Age	0.012	0.010	1.419	1	0.234	1.012	0.992	1.033
DES	0.181	0.193	0.879	1	0.349	1.199	0.821	1.751
DMDuration	0.025	0.014	3.165	1	0.075	1.025	0.997	1.054
DMEducator(1)	-0.324	0.283	1.313	1	0.252	0.723	0.416	1.259
Education	0.670	0.219	9.330	1	0.002	1.955	1.217	3.005
RP_SMBG	0.167	0.076	4.886	1	0.027	1.182	1.019	1.371
Constant	-3.889	1.245	9.762	1	0.002	0.020		
N=367								

DES=Diabetes Empowerment Scale; DMDuration= Years since T2DM diagnosis; Saw DM Educator=Previously visited with Certified Diabetes Educator;
RP_SMBG=Risk Perception of Self-Monitoring of Blood Glucose

The final model also revealed a significant correlation between risk perception of SMBG and adherence to SMBG when controlling for age, DES, duration of T2DM, education, and history of a visit with a certified diabetes educator. Specifically, each increment of increase in risk perception score increased the likelihood of scoring at least a 4 on the SMBG subscale of the SDSCA by 1.182 times; thus, respondents scoring a 13 were 8.274 times more likely than those scoring a 6 (minimum score in this study sample) to score at least a 4 on the SMBG subscale of the SDSCA.

A separate regression model was estimated to explore the relationship between SMBG adherence and benefit perception of SMBG. The final model is reported in Table 17. The base model (constant) correctly predicted 50.9% of cases, while the full model correctly reported 62.9% of cases, which indicates an improvement over the base model. The Omnibus Test of Model Coefficients “goodness of fit” (χ^2=30.207, df=6, p=0.000) also indicates the improvement of the full model of the base model. The Hosmer and Lemeshow Test (χ^2=8.405, df=8, p=0.395) indicates that the full model is a good fit. The final model, as depicted in Table 17, is Logit (SMBG)= 1.868 (Education) + 1.404 (B_SMBG).

Table 17.
Logistic Regression to Measure the Association between SMBG Adherence and Benefit Perception of SMBG

							95% CI for Exp(B)	
	B	S.E.	Wald	Df	Sig.	Exp(B)	Lower	Upper
Age	0.014	0.010	1.864	1	0.172	1.014	0.994	1.035
DES	0.152	0.193	0.621	1	0.431	1.164	0.797	1.701
DMDuration	0.027	0.014	3.750	1	0.053	1.028	1.000	1.057
DMEducator(1)	-0.296	0.284	1.090	1	0.296	0.744	0.427	1.297
Education	0.625	0.220	8.072	1	0.004	1.868	1.214	2.875
B_SMBG	0.339	0.117	8.381	1	0.004	1.404	1.116	1.767
Constant	-4.091	1.128	13.161	1	0.000	0.017		
N=367								

DES=Diabetes Empowerment Scale; DMDuration=Years since T2DM diagnosis; Saw DM Educator=Previously visited with Certified Diabetes Educator Education=College graduate (1); B_SMBG=Benefit Perception of Self-Monitoring of Blood Glucose

Similar to the previous model that instead included risk perception of SMBG as a predictor, this model again suggests a significant positive correlation between college education and adherence to SMBG when controlling for controlling for age, DES, duration of T2DM, history of a visit with a certified diabetes educator, and benefit perception of SMBG. Specifically, college-educated individuals were nearly twice as likely (1.868 times) to score at or above the median on the blood glucose subscale of the SDSCA in this model. Benefit perception of SMBG was also found to be significantly positively correlated with adherence to SMBG. Specifically, each increment of increase in benefit perception of SMBG score increased the likelihood of scoring at least a 4 on the SMBG subscale of the SDSCA by 1.404 times; thus, using this model respondents scoring a 7 were 8.424 times more likely than those scoring a 1 to score 4 or greater on the SMBG subscale of the SDSCA.

Diet Adherence Logistic Regression

To create two dichotomous groups from the general diet subscale of the Summary of Diabetes Self-Care Activities it was decided to transform SDSCA general diet into respondents who scored a 5 or greater (1=Diet Adherent) and those who scored less than 4 on the general diet subscale (0=Diet nonadherent), which was used as the dependent variable in the following logistic regression analysis. The decision to dichotomize the SMBG subscale in this manner was based on the median value of the subscale (median=5).

See Table 18 for the correlations between control variables and respondents scoring at or above the median and those scoring below the median of the general diet subscale of the SDSCA. Because of the respective p-values of the correlation coefficients between respondents who were above/below median of the general diet subscale of the SDSCA and their perceptions of harm, benefit, and risk of both high sugar foods and high fat foods, it was determined to use harm (r=-0.097, p=0.061) and risk (r=0.102 , p=0.050) of high fat foods as independent variables in separate logistic regression analyses.

A logistic regression model was estimated using the enter method to explore the relationship between diet adherence and risk perception of SMBG. The final model is reported in Table 19. The base model (constant) correctly predicted 53.9% of cases, while the full model correctly predicted 64.3% of cases, which indicates an improvement over the base model. The Omnibus Test of Model Coefficients “goodness of fit” (χ^2=35.664, df=5, p=0.000) also indicates the improvement of the full model of the base model. The Hosmer and Lemeshow Test (χ^2=1.505, df=8, p=0.993) indicates that the full model is a good fit. The final model, as depicted in Table 19, is Logit (GeneralDiet)= 2.303 (DES) + 1.143 (RP_HFF).

Table 18. Correlations between General Diet Adherence and Control Variables

Variable	Level of Measurement	Test Statistic	r or χ^2 (df)	p-value*
Age	Scale	r	0.135	0.010
Income	Scale	r	0.049	0.355
Threat	Scale	r	-0.092	0.080
DES	Scale	r	0.220	0.000
DM Duration	Scale	r	-0.051	0.335
Gender	Nominal	χ^2	0.003(1)	0.960
Education	Nominal	χ^2	0.965(1)	0.326
Married	Nominal	χ^2	3.123(1)	0.077
Saw DM Educator	Nominal	χ^2	1.724(1)	.189

* Correlation coefficients of at least p<0.1 were used in the respective model.
Threat=Threat of diabetes; DES=Diabetes Empowerment Scale; DM Duration=Years since T2DM diagnosis; Education= College graduate(1); Saw DM Educator=Previously visited with Certified Diabetes Educator

Table 19.
Logistic Regression to Measure the Association between General Diet Adherence and Risk Perception of High Fat Foods

							95% CI for Exp(B)	
	B	S.E.	Wald	Df	Sig.	Exp(B)	Lower	Upper
Married(1)	-0.453	0.249	3.314	1	0.069	0.635	0.390	1.035
Age	0.019	0.010	3.488	1	0.062	1.019	0.999	1.039
Threat	-0.009	0.025	0.121	1	0.728	0.991	0.943	1.042
DES	0.834	0.212	15.497	1	0.000	2.303	1.520	3.490
RP_HFF	0.134	0.051	6.849	1	0.009	1.143	1.034	1.263
Constant	-4.354	1.147	14.401	1	0.000	0.013		
N=373								

Threat=Threat of diabetes; DES=Diabetes Empowerment Scale; RP_HFF=Risk Perception of High Fat Foods

The final model revealed a significantly positive correlation between adherence to general diet recommendations for healthy eating and DES when controlling for age, threat, and the risk perception of high fat foods. Respondents who scored a 5 on the DES were 9.212 times more likely to follow the healthy diet recommendations than those who score a 1 in this model. Risk perception of high fat foods was also significantly positively correlated with adherence to general diet recommendations for health eating in the final model when controlling for age, threat, and the DES. Specifically, in this model respondents who scored a 13 on RP_HFF were 13.716 times more likely to follow healthy diet recommendations than those who scored a 1.

The logistic regression model with the same predictors was also computed using harm perception and benefit perception of high fat foods as predictors (in separate models). Benefit perception was not a significant predictor (Exp(B)=1.167, p=0.074), while harm perception (Exp(b)=.807, p=0.011) was a significant predictor of adherence to a healthy diet in the logistic regression model; thus, paradoxically, respondents who had a higher perception of harm for high fat foods were less likely to adhere to a healthy diet.

Smoking Logistic Regression

Study participants were asked if they had smoked (at least one puff) of a cigarette in the past 7 days. This item was coded as smokers (1=yes) and nonsmokers (0=no) and used as the dependent variable in the following logistic regression analysis.

See Table 20 for the correlations between control variables and respondents self-identifying as either smokers or nonsmokers. Because of the respective p-values of the correlation coefficients between respondents who are smokers vs. nonsmokers and their respective perceptions of harm, benefit, and risk of cigarette smoking, it was determined to use harm (r=-0.175, p=0.001), benefit (r=-0.196, p=0.000) and risk (r=0.246 , p=0.000) perception as independent variables in the logistic regression analysis.

Table 20. Correlations between Cigarette Smoking Status and Control Variables

Variable	Level of Measurement	Test Statistic	r or χ^2 (df)	p-value*
Age	Scale	r	-0.128	0.015
Income	Scale	r	0.005	0.927
Threat	Scale	r	0.017	0.774
DES	Scale	r	-0.082	0.116
DM Duration	Scale	r	-0.089	0.088
Gender	Nominal	χ^2	4.691(1)	0.030
Education	Nominal	χ^2	0.207(1)	0.649
Married	Nominal	χ^2	0.524(1)	0.469
Saw DM Educator	Nominal	χ^2	0.220(1)	0.639

* Correlation coefficients of at least p<0.1 were used in the respective model.
Threat=Threat of diabetes; DES=Diabetes Empowerment Scale; DM Duration=Years since T2DM diagnosis; Education= College graduate (1); Saw DM Educator=Previously visited with Certified Diabetes Educator

A logistic regression model was estimated using the enter method to explore the relationship between adherence to recommendations to refrain from cigarette smoking and perceptions of cigarette smoking. The final model is reported in Table 21. The base model (constant) correctly predicted 88.7% of cases, while the full model correctly predicted 88.4%, which indicates that the full model is not an improvement over the base model. The Omnibus Test of Model Coefficients “goodness of fit” (χ^2=25.054, df=4, p=0.000) indicates an improvement of the full model compared to the base model. The Hosmer and Lemeshow Test (χ^2=5.350, df=8, p=0.720) indicates that the full model is a good fit. The final model, as depicted in Table 21, is Logit (Smoking)= 1.511 (RP_CS).

Table 21. Logistic Regression to Measure the Association between Smoking and Risk Perception of Cigarette Smoking

							95% CI for Exp(B)	
	B	S.E.	Wald	Df	Sig.	Exp(B)	Lower	Upper
Age	-0.027	0.016	2.834	1	0.092	0.974	0.944	1.004
DMDuration	-0.025	0.026	0.936	1	0.333	0.976	0.928	1.026
Gender (1)	0.552	0.358	2.374	1	0.123	1.737	0.860	3.508
RP_CS	0.413	0.099	17.341	1	0.000	1.511	1.244	1.835
Constant	-1.362	0.949	2.060	1	0.151	0.256		
N=371								

DMDuration=Years since T2DM diagnosis; RP_CS=Risk Perception of Cigarette Smoking

As indicated, the model suggests a significant positive correlation between risk perception of cigarette smoking and the likelihood that the individual is a cigarette smoker. Specifically, in this model an individual who scored an 8 on the Risk Perception of Cigarette Smoking scale was 10.577 times more likely to be a smoker than nonsmoker. Similarly, in separate models, the more harm (exp(B)=0.621, p=0.001) one perceived towards cigarette smoking use was a significant predictor of abstaining from cigarette smoking, and the more benefit (Exp(B)=1.551, p=0.003) one perceived towards smoking was a significant predictor of being a smoker.

Summary

Results suggest that respondents who have T2DM perceive medications as having an overall net benefit. Of those medications studied, most were deemed to be of similar benefit and harm. Differences were also seen in perceptions of oral DM drugs between users and nonusers of diabetes medications. Furthermore, differences in perception with several of the studied variables were seen between men and women. Risk perception differences were also seen between respondents with or without a history of medication side effects , and differences in risk perception were seen between groups segmented by severity of side effects experienced.

Adherence to recommended diabetes-related treatments varied among study respondents. Harm, benefit, and risk perception variables had varying effects on logistic regression models measuring association with relevant adherence measures. While perceptions of prescription medications and oral diabetes medications were not significantly correlated with medication adherence, perception of SMBG and high fat foods had significant positive correlations with blood glucose monitoring and general diet, respectively.

CHAPTER 5: Discussion

A gap in knowledge exists in the understanding of the influence of risk perception on adherence to treatments related to diabetes. The purpose of this explanatory, descriptive study was to address the perceptions of risk and its relationship with self-care adherence in those with T2DM. This discussion is structured to address the major findings found within the results of the three aims of this study, which were the following:

Aim 1: To quantitatively describe risk perception in persons with T2DM.

Aim 2: To describe levels of adherence for diabetes self-care behaviors, including medication use, diet, exercise, foot care, smoking, and self-monitoring of blood glucose.

Aim 3: To examine the relationship between risk perception and adherence to diabetes self-care behaviors, including medication use, diet, exercise, foot care, smoking, and self-monitoring of blood glucose.

Major Findings

Risk Perception in Persons with T2DM

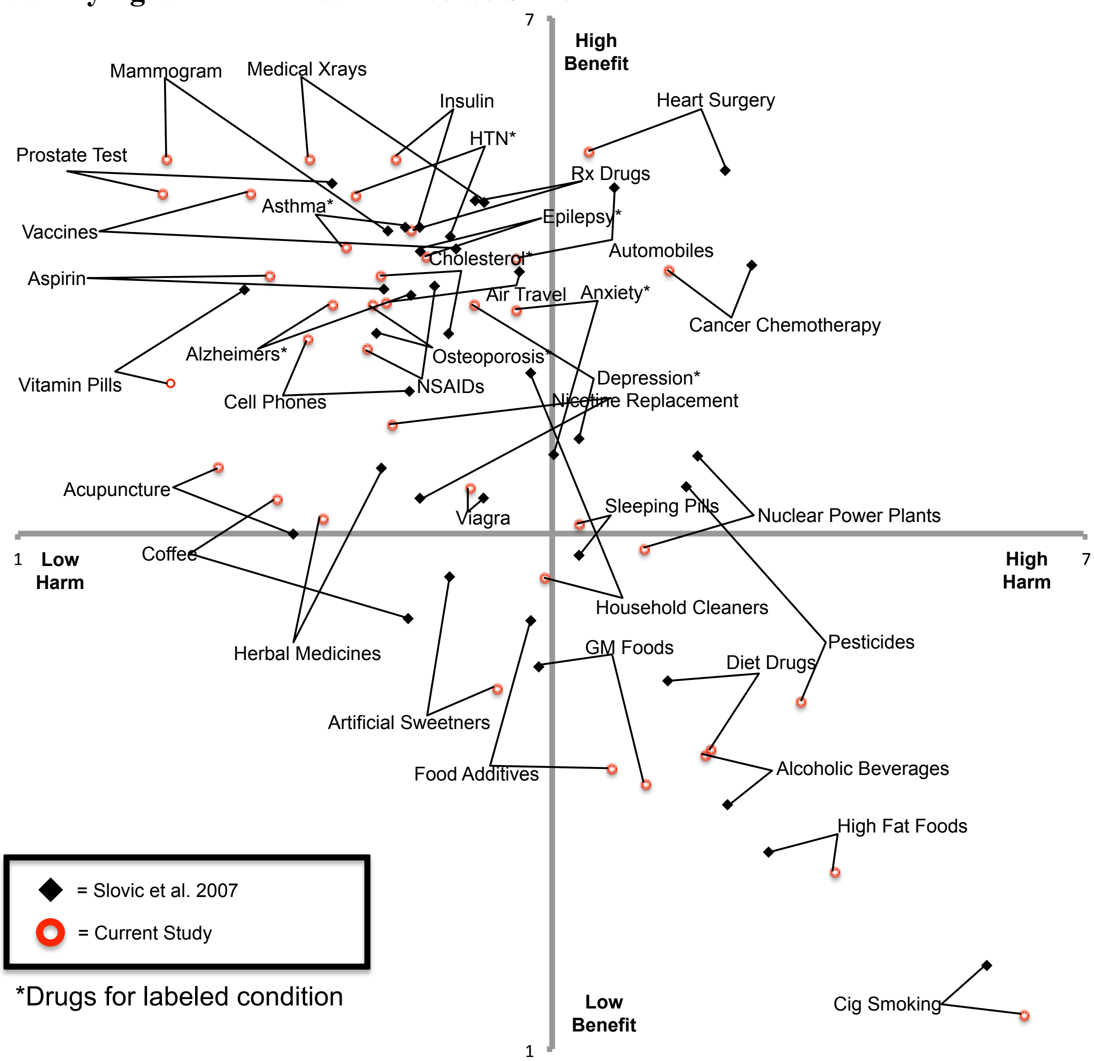
The results of this study were consistent with previous risk perception research (Slovic et al, 2007; Slovic et al., 1991; Slovic et al., 1987). In this study prescription medications were considered to be high in perceived benefit and low in perceived harm. As seen in Figure 7, most prescription medications used for diabetes and its related comorbid conditions, such as insulin, oral diabetes drugs, aspirin, and drugs for hypertension and cholesterol, are all grouped closely together. These products were markedly different from other chemicals respondents were asked to risk-rate, including pesticides, alcohol, and food additives. While respondents rated most medications similarly, diet drugs were perceived to offer similar levels of harm and benefit as alcoholic beverages.

Although not tested for statistical significance, insulin was perceived to have a higher potential for harm compared to oral diabetes drugs, while also being perceived to have more potential for benefit; however, risk perception of insulin and oral diabetes drugs (the difference between perceived benefit and perceived harm) was nearly identical.

Earlier research identified differences in risk perception between men and women (Slovic et al., 2007). Consistent with this earlier research, findings in the present study also revealed a several differences between male and female respondents. Women perceived higher harm for both nuclear power and air travel, which is similar previous research (Slovic et al., 2007). Of particular importance to patients with T2DM, women perceived a higher benefit for oral diabetes drugs, drugs for neuropathy, and self-monitoring of blood glucose.

Results from this survey were similar to those results from a national survey conducted previously in the United States. Figure 7 was compared to a similar plot of benefit and harm perceptions found in Slovic et al. (2007).

Figure 11. Plot of Mean Benefit and Harm Perception by Respondents Who Have Type 2 Diabetes Compared with Respondents from a National Survey Not Identifying with a Particular Disease State



It is of particular importance to note that previous research did not focus on subjects who were diagnosed with a particular disease; rather, the research explored if risk perceptions differed between those who took medications versus those who completely abstained from medication use for their respective conditions. Mean rankings of the individual risk items from the previous study were not available; thus, comparing risk perceptions between the two studies was only done through visual inspection of the harm and benefit plots.

All of the products located in or near the “Low Benefit-High Harm” quadrant, which included cigarette smoking, high fat foods, alcoholic beverages, diet drugs and sleeping pills, were in similar positions in their respective plots. No great deviations between the two plots were easily visualized; however, drugs for anxiety and drugs for depression appear to have been deemed less harmful and more beneficial in the current study of patients with diabetes compared to the previous study. This is of particular significance, as depression (especially in those with T2DM) has been acknowledged as a modifiable risk factor for medication nonadherence (Gellad et al., 2009).

Several items moved from their respective “quadrants” between the prior study and the current study. Please see Table 22 for a list of those products were found in different quadrants in Figure 11. Of the 10 products that changed, 3 were medication related (drugs for anxiety, drugs for depression, and sleeping pills).

Table 22. Items Switching Quadrants as Seen in Figure 11

High to Low Harm	Low to High Harm	High to Low Benefit	Low to High Benefit
Automobiles	Food Additives	Household Cleaners	Sleeping Pills
Drugs for Anxiety	Genetically Modified Foods	Nuclear Power Plants	Coffee
Drugs for Depression		Pesticides	

It is not possible to deliniate the reasons for the differences between the perceptions of depression and anxiety medications in this study's sample versus that from Slovic et al. (2007). It could simply be a regional difference (upper Midwest of the United States compared to a national sample), a true difference in how patients with T2DM perceive these medications compared to the general population, or perhaps a decrease in the stigma and and increase in the acceptance of a biological basis for mental illness. Additionally, it has been noted that pharmaceutical companies have spent tremendous sums of money on direct-to-consumer advertising with the goal of improving perceptions of drugs for mental illness (Greenslit & Kaptchuk, 2012).

Adherence to Treatments

Roughly one-third (34%) of subjects were considered nonadherent to oral diabetes medications, consistent with previous research using the Morisky Medication Adherence Scale (Walker, et al., 2011), and similar to previous medication adherence studies (Garcia-Perez, Alvarez, Dilla, Gil-Guillen, & Orozco-Beltran, 2013). As the Morisky Medication Adherence Scale is specific for oral medication use, it is unknown what adherence to insulin use was in this study sample.

Patients in this study followed recommendations for exercise less than 3 days per week on average, while nearly 1 out of every 5 patients did not exercise at all in the previous 7 days. Of all treatments examined in the current study, exercise had the lowest adherence rate. Exercise is an important component of treating T2DM, as exercise is effective at naturally lowering blood glucose (Colberg, Sigal, Fernhall, Regensteiner, Blissmer, et al., 2010; Maiorana, O'Driscoll, Goodman, Taylor, & Green, 2002). The American Diabetes Association (ADA, 2015) recommends that patients get 30 minutes of continuous exercise at least 5 days a week.

Along with medications and exercise, a healthy diet is a cornerstone of a T2DM treatment regimen. A healthy diet can greatly reduce the risk of diabetes and associated comorbidities (e.g., cardiovascular disease). The sample in the current study reported following healthy eating recommendations an average of 4.55 days of the week, but over 1 in 5 respondents followed a healthy diet less than 3 days per week, which is consistent with previous research (Carpenter, 2012).

Self-monitoring of blood glucose is a key method for patients to remain aware of their own diabetes care. Nearly 1 in 5 individuals in this study had not tested blood glucose once in the previous 7 days, while half of the respondents tested at least 4 days in the past week. Research suggests a relationship between SMBG frequency and lower A1C (Miller, Beck, Bergenstal, 2013). It is unknown whether respondents were simply nonadherent to suggested SMBG frequency, whether their respective providers chose not to give targets for SMBG (providing less incentive for patients to self-test), or both.

Most individuals in this study had not smoked a cigarette in the previous 7 days, while 11% had smoked a cigarette. This is lower than the average adult smoking rate in the State of Minnesota (14.4%; Tobacco Use in Minnesota, 2014), and in the United States (17.8%; CDC, 2013). It is not known whether individuals used other forms of tobacco (e.g., pipe, cigar, chewing, etc.) While respondents had a lower smoking rate than the Minnesota average, the decades-long trend in dropping smoking rates has slowed or plateaued, and practitioners must remain vigilant in discussing cigarette smoking with patients (CDC, 2014).

Relationship between Risk Perception and Adherence to T2DM Treatments

Logistic regression was used to identify independent variables that had statistically significant correlations with the various adherence measures. No clear pattern existed between the independent variables that were statistically correlated to the dependent variables, and significant relationships between harm, benefit, and risk perception variables with the adherence measures varied. This finding highlights the difficulty clinicians face when attempting to modify patients' behaviors, and reinforces the notion that behavior modification is time-intensive and must be patient-centric.

The Diabetes Empowerment Scale, which measures self-efficacy, was significantly correlated with the Morisky Scale (medication adherence), exercise, and diet. No other independent variable was significantly correlated with multiple adherence measures. Age was significantly correlated with medication adherence; income was significantly correlated with exercise; and education was significantly correlated with self-monitoring of blood glucose (SMBG). Because age was correlated with medication adherence, clinicians should pay particular attention to medication adherence when speaking with younger patients. Perhaps focusing on medication adherence when a patient is young will help form positive habits that will remain as patients grow older. Medication adherence barriers should be investigated that may be more pronounced in younger patients (e.g. lower income, jobs with poor health benefits, time constraints). Clinicians working with individuals with lower household incomes should focus on potential causes of exercise nonadherence. If cost of exercise is described as a barrier by patients, then a clinician can focus on areas of the household budget that could be trimmed down (e.g. cigarettes, alcohol, unhealthy food choices) to accommodate the cost of exercise (e.g. running shoes or a gym membership). Although *formal education* was correlated with SMBG, clinicians should continually focus on educating all patients about the importance of SMBG.

Risk perception of oral diabetes drugs was not significantly correlated with the Morisky (medication adherence) scale. Likewise, risk perception of moderate intensity exercise was not correlated with exercise adherence.

Cigarette smoking was significantly associated with harm of (negative correlation), benefit (positive correlation), and risk perception (negative correlation) of cigarette smoking. However, because such a high percentage of respondents reported to be nonsmokers (88.7%), the constant-only logistic regression model correctly predicted more cases than the full model. This suggests that the full model may not be useful in predicting smoking status, but the logistic regression was conducted to measure the relationship between risk, harm, and benefit perception of smoking with smoking status with no intention of creating a model to use for future predictions of cigarette smoking.

Risk and benefit perception of SMBG was significantly correlated with SMBG adherence. Similarly, risk and harm perception of high fat foods was significantly correlated with general diet adherence. Importantly, a *decrease* in perceived harm from high fat foods increased adherence to the general diet subscale of the SDSCA. Benefit of high fat foods was not correlated nor was risk, harm, or benefit perception of high sugar foods correlated with adherence to a healthy diet. It may seem contradictory that a decrease in harm perception of high fat foods would lead to improved adherence to a healthy diet; however, it could be hypothesized that those who understand the role of fats in a diet will follow an all-around healthier eating plan.

Both risk and benefit perceptions of SMBG were significant predictors of the likelihood that an individual in this study would test blood glucose more than the median number of days reported by respondents. Along with the previously mentioned differences in perception of blood glucose testing between men and women, it appears that this is a good area for enhanced discussion. Awareness of blood glucose control could provide increased autonomy over one's health and will provide feedback as to how other areas of self-care (i.e. medications, exercise, and diet) are lowering blood glucose. Knowing target blood glucose values and why reaching those targets are important may empower patients to control their diabetes.

Perceived threat, as measured by the Perceived Threat subscale of the Cognitive Appraisal of Health Scale, did not appear to be significantly correlated to the various studied adherence measures, which is in contrast to previously mentioned research (Carpenter, 2012). Internal consistency with the scale was acceptable with a Cronbach's alpha of 0.859; therefore, it is unclear whether perceived threat of T2DM truly does not influence one's adherence to self-care treatments or if the scale used accurately measures the perceived threat concept in this population.

Implications

Analysis of the results of this study suggest a potential link between risk perceptions and adherence to diabetes-related self-care treatments; however, when considering these associations, one should remember that this study was conducted in a small sample from one region, and the study is not a replication of previous research. Thus, conclusions are not definitive and should not be used across the broader population of patients with T2DM.

The respondents in this study had varying degrees of adherence to diabetes-related treatments. Adherence rates for the various self-care activities were similar to previously studied groups (Carpenter, 2012; Gonzalez, Safren, Cagliero, Wexler, Delahanty, Wittenberg, …, & Grant, 2007). As such, practitioners and patients should continually focus on increasing the rates of adherence to the various activities. The adherence scales used for this study, the SDSCA and MMAS-8, take patients little time to complete, yet yield excellent insight into self-care areas that might benefit from attention. Gaining insight behind adherence also allows the patient and practitioner to focus attention at the area(s) that might most increase adherence rates. Each treatment recommendation, whether for medications, diet, or exercise, has multifactorial causes for nonadherence, and adherence to one area does not imply adherence to another. Thus, each treatment area should be independently assessed for adherence. However, because most treatment areas in the current study saw relatively high rates of nonadherence (e.g. 1 in 5 never self-monitored blood glucose and nearly 30% were nonadherent to medications), most patients would benefit from routine reminders about the importance of lifestyle modifications and medications.

The Diabetes Empowerment Scale had significant positive correlations with medication, exercise, and diet adherence. With the little time providers are afforded to educate patients, it would be best to focus on areas that have the most evidence-based support; focusing on increasing patient self-efficacy may be a productive way to improve multiple areas of self-care.

It is interesting to note that high fat and high sugar foods had nearly identical benefit and harm perceptions, and they also had risk perceptions that were viewed similarly to electronic cigarettes but were perceived to be more harmful than alcoholic beverages and diet drugs. The sample in this study perceived the benefits and harms of high fat foods similarly to previous studies even as research suggests that evidence did not support decades-old dietary fat intake guidelines (Harcombe et al., 2015). Because of the relationship between T2DM and carbohydrates, it is understandable that patients would view high sugar foods as harmful; however, viewing high fat foods as having equal possibility of harm compared to high sugar foods shows a possible failure in nutrition advice. Excess carbohydrates are an indisputable cause of T2DM, and uncontrolled blood glucose is what leads to the untoward complications of the disease.

Much evidence has emerged that dietary fat and cholesterol is not as detrimental as once thought, and can even be cardio protective in those with T2DM (Hu, Cho, Rexrode, Albert, & Manson, 2003). In fact, many of the diets often considered to lower risk of heart disease have higher fat content (e.g. Mediterranean; Estruch, Ros, Salas-Salvado, Covas, Corella, et al., 2013). Furthering the need to focus on this area of education, recent research has pointed to high fat diets as producing more sustainable weight loss compared to high carbohydrate diets (Bazzano et al., 2014). Health practitioners could consider discussing the positives and negatives of high fat compared with high sugar foods.

Relative to all items included in the risk perception portion of this study, patients perceived moderate intensity exercise as the fifth least harmful and tenth most beneficial; however, perception of moderate intensity exercise was not significantly correlated with exercise adherence. As was stated above, self-efficacy was significantly correlated with the likelihood to exercise. Thus, empowering individuals to exercise should be a key component when discussing this issue with patients. Exercise does not need to be costly, and although time cost can be expensive (especially for those needing to work multiple jobs), patients should be motivated to add physical activity throughout the day (e.g. parking farther away from work or taking the stairs instead of the elevator). The American Diabetes Association recommends at least 150 minutes of exercise per week broken up into at least 30-minute segments with no more than two consecutive days off per week (ADA, 2015). Research suggests that breaking the 30 minutes into smaller time segments can still yield significant results (Bhammar, Angadi, & Gaesser, 2012). So, all amounts of exercise should be encouraged instead of creating an “If I can’t get in 30 minutes, I might as well not even try” mentality. The use of pedometers or journaling may also be of benefit to lessen discouragements if “results” are not achieved quickly enough. Likewise, if subjective results are largely based on weight loss and physique, it is important to educate that no amount of exercise can compensate for an unhealthy, high calorie diet.

Risk Perception

Risk perception of diabetes medications does not appear to be significantly correlated with medication adherence in this sample, even though it has been previously connected to users and abstainers of medications (Slovic et al., 2007). Factors leading to medication nonadherence have been linked to cost, regimen, and medication beliefs; however, in this study risk perception of oral diabetes drugs (medication belief) was not significantly correlated with medication adherence. This is an instance where a “negative” result is as important as a positive correlation. With the limited time and resources that practitioners can devote to individual patients, it is important that practitioners focus attention on the areas that will change behaviors and improve morbidity and mortality. Thus, this research suggests that clinicians should spend a lot of limited face-to-face time with patients discussing potential harms and benefits of oral T2DM drugs, but should balance this discussion with other education topics that might aid in modifying self-care behaviors.

It has been acknowledged in previous research that spouses play an important role in influencing their partners’ treatment adherence for chronic illnesses (Ell, 1996;

Revenson, 2003). In the current study, women perceived more benefit than men from oral DM drugs and SMBG. Recognizing that women are more inclined to see the benefit from oral DM drugs and SMBG, it may be prudent to educate patients' female partners with the goal of them discussing diabetes-related issues with male patients. This could be of particular importance with SMBG, which was significantly positively correlated with likelihood to test blood glucose in this study.

Limitations

This explanatory, descriptive study has several limitations that need to be acknowledged. First, the study design was based on a self-selected sample of patients with T2DM who had received care at an Essentia Health facility at least once over the previous three years. All collected data was based on self-report and was not independently verified using a medical record.

The study was only delivered electronically to those patients that had email addresses on file. It was impossible to know how many patients had actually read the request to participate in the study, and due to privacy constraints placed on the study by Essentia Health, survey emails were only sent once to each sampled participant. Because it was completed online, it was also impossible to verify that the self-reported data was accurate. Although guaranteeing the anonymity of respondents was a paramount consideration in this study, individuals invited to participate may still have been skeptical that they were being "tracked," so either did not participate in the survey at all or answered less-than-truthfully. Online surveys also preclude those who do not have email addresses on file or who do not have the computer skills required to navigate an online survey. The response rate (8.1%) was low. A comparison of paper-based vs. online-based survey response rates shows online response rates between 20%-47%, which were up to 35% lower than their respective paper-based surveys (Nulty, 2008). Because of the low response rate, nonresponse bias must be considered, which is especially true considering the demographics of this sample do not mirror the general population. However, a low response rate does not automatically mean the results are unrepresentative of the broader population (Visser, Krosnick, Marquette, & Curtin, 1996).

Multicollinearity of variables in the logistic regression analysis is a possible limitation, which can make interpreting significance tests of the individual predictors in the logistic regression models difficult to interpret. Additionally, the study did not control for confounding factors that may have influenced the dependent variables. As acknowledged several times previously, causes of nonadherence are multifactorial and individualistic, and it was not feasible (or possible) to gather all possible independent variables that influence adherence to diabetes-related treatments.

As with any study using scales there are inherent issues with scale design that create limitations. There is currently not a "best practice" for measuring medication adherence, and the Morisky Medication Adherence Scale is considered "gold standard" when using survey methodology, but the survey does not allow one to know if the subject actually used the medication as directed. Similar issues were identified in the SDSCA. For example, with the SMBG questions subjects were asked to indicate the number of days during the last week that they had tested blood sugar the number of times recommended by a healthcare provider. If a healthcare provider indicated zero times then the subject would be correct to mark "zero," but this would then lower the mean response and indicate poor adherence to SMBG.

Future Research

This study emphasizes the need for more research exploring the relationship between not only T2DM and risk perception, but also the relationship between risk perception and other disease states. Of particular note is the perception this sample had of cancer chemotherapy, which is sometimes the best option for cancer treatment, but is also known for its horrendous side effects. Alternatively, research could focus on the differences between perceptions of those with ailments that one can "feel" (e.g. migraines) versus "silent" conditions (e.g. hyperlipidemia).

As was noted earlier in this chapter, perception of high-fat foods was significantly correlated with eating an overall healthier diet. With all of the inappropriate and misguided information swirling around the press regarding dietary fats, future research could explore patients' understanding of healthy versus unhealthy diets, and how fats and carbohydrates contribute to diabetes and related comorbidities.

Future research could focus on matching providers' risk profiles to those of their respective patients. Perhaps patients who have harm and benefit perception of various treatment modalities that are similar to those of their respective providers will achieve better outcomes than those patients whose perceptions are not in alignment with their providers. Similarly, research could investigate how providers' risk perceptions influence clinical decisions and treatment recommendations.

Studies focusing on adherence to treatments generally have inherent methodological issues with regards to measurement of adherence. While the 8-item Morisky Medication Adherence Scale (MMAS-8) was used for this study, there is no gold standard, and measuring medication adherence using additional methods (e.g. percent of days covered, self-reported medication taking journal, vial cap that logs openings, etc.) might yield different results and conclusions. Likewise, adherence to self-care treatments in the SDSCA (i.e., diet, exercise, and SMBG) could be measured in many various ways, which might yield different results.

Future research could also explore if “harm” and “benefit” is too simplistic. Risk perception was separated into those opposing constructs for this study because of previous research on the topic (Fischoff et al., 1978; Slovic et al., 2007) and the desire to have study questions that the general public could comprehend. Moreover, optimism bias has been noted in previous risk perception research (Walker et al., 2003), and the harm and benefit perception questions asked in this particular study might have elicited similar biases.

Previous research has found that risk perception differs between different races/ethnicities (Slovic, 2007). It was decided not to include race as a control variable in this study because of the geographic location of the sample, which would yield such a small proportion of non-white respondents as to render sub-analyses based on race meaningless and/or difficult to interpret. Therefore, future research could explore both if race and if geographic location influences risk perception and adherence to treatments.

Conclusion

Much research has been conducted to elucidate the causes of nonadherence and methods for improving adherence to diabetes-related treatments; yet, adherence remains woefully poor through all sectors of society. Gaining insight into how persons who live with a diagnosis of T2DM perceive the harms and benefits of diabetes-related self-care treatments in relation to other medical and nonmedical products and activities may help with other areas of diabetes treatment adherence research.

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Appendix 1. Risk Perception Items

1. Pharmaceutical items			
1	Drugs for depression	13	Drugs for Alzheimer's disease
2	Drugs for erectile dysfunction (Viagra)	14	Drugs for anxiety
3	Drugs for epilepsy	15	Nicotine replacement (patches)
4	Influenza vaccination	16	Herbal medicines
5	Drugs for Osteoporosis	17	Cancer chemotherapy
6	Sleeping pills	18	Aspirin
7	Drugs for asthma	19	Drugs for cholesterol
8	NSAIDS (Advil)	20	Prescription drugs
9	Insulin	21	Blood pressure drugs
10	Vitamin pills	22	Drugs for diabetes (non-insulin)
11	Diet drugs	23	Over-the-counter (OTC) drugs
12	Vaccines	24	Drugs for neuropathy (nerve pain)
2. Medical procedures, tests, devices			
23	Prostate screening tests	26	Medical x-rays
24	Heart surgery	27	Blood glucose lancet
25	Mammogram	28	Acupuncture
3. Nonmedical hazards			
29	Cell phones	37	Food additives
30	Cigarette smoking	38	Alcohol beverages
31	High-fat foods	39	Moderate-Intensity Exercise
32	Automobiles	40	Artificial sweeteners
33	Air Travel	41	Pesticides
34	Coffee	42	High-sugar foods
35	Electronic cigarettes	43	Genetically modified food
36	Household cleaners	44	Nuclear power plants

Appendix 2. Perceived Threat Subscale of the Cognitive Appraisal of Health Scale

	strongly disagree 1	disagree 2	undecided 3	agree 4	strongly agree 5
Diabetes is frightening to me.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Things will only get worse because of having diabetes.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
My diabetes will not go well.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
I have a lot to lose because of having diabetes.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
I worry about what will happen to me.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Appendix 3. 8-Item Morisky Medication Adherence Scale

Do you sometimes forget to take your diabetes pills?

☐ Yes ☐ No

People sometimes miss taking their medications for reasons other than forgetting. Thinking over the past two weeks, were there any days when you did not take your diabetes medicine?

☐ Yes ☐ No

Have you ever cut back or stopped taking your medication without telling your doctor, because you felt worse when you took it?

☐ Yes ☐ No

When you travel or leave home, do you sometimes forget to bring along your diabetes medication?

☐ Yes ☐ No

Did you take your diabetes medicine yesterday?

☐ Yes ☐ No

When you feel like your diabetes is under control, do you sometimes stop taking your medicine?

☐ Yes ☐ No

Taking medication everyday is a real inconvenience for some people. Do you ever feel hassled about sticking to your diabetes treatment plan?

☐ Yes ☐ No

How often do you have difficulty remembering to take all your medications?

☐ Never/Rarely
☐ Once in a while
☐ Sometimes
☐ Usually
☐ All the time

Appendix 4. Summary of Diabetes Self-Care Activities Scale

Diet	**Days**							
How many of the last SEVEN DAYS have you followed a healthful eating plan?	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
On average, over the past month, how many DAYS PER WEEK have you followed your eating plan?	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
On how many of the last SEVEN DAYS did you eat five or more servings of fruits and vegetables?	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
On how many of the last SEVEN DAYS did you eat high fat foods such as red meat or full-fat dairy products?	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Exercise								
On how many of the last SEVEN DAYS did you participate in at least 30 minutes of physical activity? (Total minutes of continuous activity, including walking).	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
On how many of the last SEVEN DAYS did you participate in a specific exercise session (such as swimming, walking, biking) other than what you do around the house or as part of your work?	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Blood Sugar Testing								
On how many of the last SEVEN DAYS did you test your blood sugar?	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
On how many of the last SEVEN DAYS did you test your blood sugar the number of times recommended by your health care provider?	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Foot Care								
On how many of the last SEVEN DAYS did you check your feet?	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
On how many of the last SEVEN DAYS did you inspect the inside of your shoes?	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Smoking								
Have you smoked a cigarette—even one puff—during the past SEVEN DAYS?	☐ No				☐ Yes			
If you answered *yes* above, how many cigarettes did you smoke on an average day?	Number of cigarettes:_______							

Appendix 5. Diabetes Empowerment Scale—Short Form

In general, I believe that I:	strongly disagree 1	disagree 2	undecided 3	agree 4	strongly agree 5
a. ...know what part(s) of taking care of my diabetes that I am **dissatisfied** with.	□ 1	□ 2	□ 3	□ 4	□ 5
b. …am able to turn my diabetes goals into a workable plan.	□ 1	□ 2	□ 3	□ 4	□ 5
c. ...can try out different ways of overcoming barriers to my diabetes goals.	□ 1	□ 2	□ 3	□ 4	□ 5
d. ...can find ways to feel better about **having** diabetes.	□ 1	□ 2	□ 3	□ 4	□ 5
e. ...know the **positive** ways I cope with diabetes-related stress.	□ 1	□ 2	□ 3	□ 4	□ 5
f. ...can ask for support for having and caring for my diabetes when I need it.	□ 1	□ 2	□ 3	□ 4	□ 5
g. ...know what helps me stay motivated to care for my diabetes.	□ 1	□ 2	□ 3	□ 4	□ 5
h. ...know enough about myself as a person to make diabetes care choices that are right for me.	□ 1	□ 2	□ 3	□ 4	□ 5

Appendix 6. Online-based Survey

Dear Essentia Health Patient:

I am writing to ask for your help in a health study by completing the attached questionnaire. This study is being conducted at the Essentia Institute of Rural Health in collaboration with the University of Minnesota-Duluth. The purpose of this study is to better understand how opinions of different risks effect decisions to follow suggested medical treatments in people with type II diabetes mellitus. The ultimate goal is to help improve the communication and education health care professionals provide to their patients.You have been randomly selected for this study. All patients with diabetes who have received care with an Essentia Health affiliated clinic for at least one year were eligible to be randomly selected. Your participation in the study is voluntary, and your answers are private and confidential. Only the overall results will be reported. Your name will never be associated with the answers you provide. The questionnaire should take less than 20 minutes of your time.If you have any questions about the survey, please feel free to contact Dr. Steve Waring at 218-786-1280.This study has been reviewed and approved by the Essentia Health Institutional Review Board regarding research on human subjects study #EH14351. If you have a question about this aspect of the study, please call the IRB office at 218-786-3215. For questions about your rights as a research participant, contact Ms. Vicki Clevenger, Vice President, Compliance & Audit/Chief Compliance Officer for Essentia Health, at 218-786-3539.In closing, I would like to emphasize your importance in this study. Your answers will help to understand the issues that people with diabetes face when treating diabetes. Please participate if you can.

Sincerely,

Stephen Waring, DVM, PhD
Senior Research Scientist

Q43 Would you like to take the survey?
- Yes (1)
- No (2)

If No Is Selected, Then Skip To End of Survey

Q37 Have you been told that you have type 2 diabetes (formerly called adult-onset diabetes)?
- Yes (1)
- No (2)

If Yes Is Selected, Then Skip To Do you currently use oral medications...

Q39 Do you have diabetes?
- Yes (1)
- No (2)

If No Is Selected, Then Skip To Do you currently use oral medications...

Q41 What type of diabetes do you have? Please enter in the space below. Please say "unsure" if you do not know the type of diabetes that you have.

Q1 Do you currently use oral medications to treat diabetes?
- Yes (1)
- No (2)

Q2 Do you currently use insulin to treat diabetes?
- Yes (1)
- No (2)

Q5 For this question, please only consider the medications you take for diabetes. Over the previous 5 years have you experienced side effects from DIABETES medications?
- Yes (1)
- No (2)
- Unsure if side effects were caused by diabetes medications (3)

If No Is Selected, Then Skip To Thinking about the previous 5 years, ...If Unsure if side effects were... Is Selected, Then Skip To Thinking about the side effects you p...

Q6 Thinking about the side effects you experienced in the previous 5 years from diabetes medications, overall would you say that the severity of the side effects were:
- Mild (1)
- Moderate (2)
- Severe (3)

If Mild Is Selected, Then Skip To Again, think about the previous 5 yea...If Moderate Is Selected, Then Skip To Again, think about the previous 5 yea...If Severe Is Selected, Then Skip To Again, think about the previous 5 yea...

Q38 Thinking about the side effects you possibly experienced in the previous 5 years from diabetes medications, overall would you say that the severity of the side effects were:

- ❍ Mild (1)
- ❍ Moderate (2)
- ❍ Severe (3)

Q3 Again, think about the previous 5 years, do you remember having side effects from ANY medications?

- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To End of Block

Q4 Overall, would you say that the severity of the side effects you experienced over the last 5 years were:

- ❍ Mild (1)
- ❍ Moderate (2)
- ❍ Severe (3)

Q7 Individuals have identified many issues regarding their use of medications and we are interested in your experiences. There are no right or wrong answers. Please answer each question based on your personal experience with diabetes.

	Yes (1)	No (2)
Do you sometimes forget to take your diabetes pills? (1)	❍	❍
People sometimes miss taking their medications for reasons other than forgetting. Thinking over the past TWO WEEKS, were there any days when you did not take your diabetes medicine? (2)	❍	❍
Have you ever cut back or stopped taking your medication without telling your doctor because you felt worse when you took it? (3)	❍	❍
When you travel or leave home, do you sometimes forget to bring along your diabetes medication? (4)	❍	❍
Did you take your diabetes medicine yesterday? (5)	❍	❍
When you feel like your diabetes is under control, do you sometimes stop taking your medicine? (6)	❍	❍
Taking medication everyday is a real inconvenience for some people. Do you ever feel hassled about sticking to your diabetes treatment plan? (7)	❍	❍

Q8 How often do you have difficulty remembering to take all of your medications?

❍ Never/Rarely (1)

❍ Once in a while (2)

❍ Sometimes (3)

❍ Usually (4)

❍ All the time (5)

Q9 In this section, please answer how much you agree or disagree with the following questions regarding how you feel about diabetes.

	Strongly Disagree (1)	Disagree (2)	Undecided (3)	Agree (4)	Strongly Agree (5)
Diabetes is frightening to me. (1)	❍	❍	❍	❍	❍
Things will only get worse because of having diabetes. (2)	❍	❍	❍	❍	❍
My diabetes will not go well. (3)	❍	❍	❍	❍	❍
I have a lot to lose because of having diabetes. (4)	❍	❍	❍	❍	❍
I worry about what will happen to me. (5)	❍	❍	❍	❍	❍

Q10 This next section is going to include a list of medications, medical tests and procedures, and other nonmedical items or activities. Please consider the potential negative effects of the items or activities. Specifically, to what extent would you say that people who are exposed to (or use) this item are at risk of experiencing personal harm from it? Possible answers range from 1 to 7, with 1 equaling Not at Risk and 7 equaling Very Much at Risk.

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Drugs for depression (1)	❍	❍	❍	❍	❍	❍	❍
Drugs for erectile dysfunction (Viagra) (2)	❍	❍	❍	❍	❍	❍	❍
Drugs for epilepsy (3)	❍	❍	❍	❍	❍	❍	❍
Influenza vaccination (4)	❍	❍	❍	❍	❍	❍	❍
Drugs for osteoporosis (5)	❍	❍	❍	❍	❍	❍	❍
Sleeping pills (6)	❍	❍	❍	❍	❍	❍	❍
Drugs for asthma (7)	❍	❍	❍	❍	❍	❍	❍
NSAIDS (Advil or Aleve) (8)	❍	❍	❍	❍	❍	❍	❍
Insulin (9)	❍	❍	❍	❍	❍	❍	❍
Vitamin pills (10)	❍	❍	❍	❍	❍	❍	❍
Diet drugs (11)	❍	❍	❍	❍	❍	❍	❍
Vaccines (12)	❍	❍	❍	❍	❍	❍	❍
Drugs for Alzheimer's disease (13)	❍	❍	❍	❍	❍	❍	❍
Drugs for anxiety (14)	❍	❍	❍	❍	❍	❍	❍

Nicotine replacement (patches) (15)	❍	❍	❍	❍	❍	❍	❍
Herbal medicines (16)	❍	❍	❍	❍	❍	❍	❍
Cancer chemotherapy (17)	❍	❍	❍	❍	❍	❍	❍
Aspirin (18)	❍	❍	❍	❍	❍	❍	❍
Drugs for cholesterol (19)	❍	❍	❍	❍	❍	❍	❍
Prescription drugs (20)	❍	❍	❍	❍	❍	❍	❍
Blood pressure drugs (21)	❍	❍	❍	❍	❍	❍	❍
Drugs for diabetes (non-insulin) (22)	❍	❍	❍	❍	❍	❍	❍
Over-the-counter (OTC) drugs (23)	❍	❍	❍	❍	❍	❍	❍
Drugs for neuropathy (nerve pain) (24)	❍	❍	❍	❍	❍	❍	❍

Q11 As a reminder, the question being asked is: To what extent would you say that people who are exposed to (or use) this item are at risk of experiencing personal harm from it?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Prostate screening tests (1)	❍	❍	❍	❍	❍	❍	❍
Mammogram (2)	❍	❍	❍	❍	❍	❍	❍
Heart surgery (3)	❍	❍	❍	❍	❍	❍	❍
Medical x-rays (4)	❍	❍	❍	❍	❍	❍	❍
Self-monitoring of blood glucose (using lancets) (5)	❍	❍	❍	❍	❍	❍	❍
Acupuncture (6)	❍	❍	❍	❍	❍	❍	❍

Q12 Again, please answer the following question: To what extent would you say that people who are exposed to (or use) this item or activity are at risk of experiencing personal harm from it?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Cell phones (1)	❍	❍	❍	❍	❍	❍	❍
Cigarette smoking (2)	❍	❍	❍	❍	❍	❍	❍
High-fat foods (3)	❍	❍	❍	❍	❍	❍	❍
Automobiles (4)	❍	❍	❍	❍	❍	❍	❍
Air travel (5)	❍	❍	❍	❍	❍	❍	❍
Coffee (6)	❍	❍	❍	❍	❍	❍	❍
Electronic cigarettes (7)	❍	❍	❍	❍	❍	❍	❍

Household cleaners (8)	❍	❍	❍	❍	❍	❍	❍
Food additives (9)	❍	❍	❍	❍	❍	❍	❍
Alcoholic beverages (10)	❍	❍	❍	❍	❍	❍	❍
Moderate-intensity exercise (11)	❍	❍	❍	❍	❍	❍	❍
Artificial sweeteners (12)	❍	❍	❍	❍	❍	❍	❍
Pesticides (13)	❍	❍	❍	❍	❍	❍	❍
High-sugar foods (14)	❍	❍	❍	❍	❍	❍	❍
Genetically modified foods (15)	❍	❍	❍	❍	❍	❍	❍
Nuclear power plants (16)	❍	❍	❍	❍	❍	❍	❍

Q13 This next section is going to include the same list of medications, medical tests and procedures, and other nonmedical items or activities as the previous section. This time, we ask that you consider the potential positive effects of using the items or activities. In general, how beneficial do you consider this item or activity to be? Similar to the previous section, possible answers will range from 1 to 7, but in this section, 1 will equal Not at All Beneficial and 7 will equal Very Beneficial.

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Drugs for depression (1)	❍	❍	❍	❍	❍	❍	❍
Drugs for erectile dysfunction (Viagra) (2)	❍	❍	❍	❍	❍	❍	❍
Drugs for	❍	❍	❍	❍	❍	❍	❍

epilepsy (3)							
Influenza vaccination (4)	❍	❍	❍	❍	❍	❍	❍
Drugs for osteoporosis (5)	❍	❍	❍	❍	❍	❍	❍
Sleeping pills (6)	❍	❍	❍	❍	❍	❍	❍
Drugs for asthma (7)	❍	❍	❍	❍	❍	❍	❍
NSAIDS (Advil or Aleve) (8)	❍	❍	❍	❍	❍	❍	❍
Insulin (9)	❍	❍	❍	❍	❍	❍	❍
Vitamin pills (10)	❍	❍	❍	❍	❍	❍	❍
Diet drugs (11)	❍	❍	❍	❍	❍	❍	❍
Vaccines (12)	❍	❍	❍	❍	❍	❍	❍
Drugs for Alzheimer's disease (13)	❍	❍	❍	❍	❍	❍	❍
Drugs for anxiety (14)	❍	❍	❍	❍	❍	❍	❍
Nicotine replacement (patches) (15)	❍	❍	❍	❍	❍	❍	❍
Herbal medicines (16)	❍	❍	❍	❍	❍	❍	❍
Cancer chemotherapy (17)	❍	❍	❍	❍	❍	❍	❍
Aspirin (18)	❍	❍	❍	❍	❍	❍	❍
Drugs for cholesterol (19)	❍	❍	❍	❍	❍	❍	❍
Prescription	❍	❍	❍	❍	❍	❍	❍

drugs (20)							
Blood pressure drugs (21)	❍	❍	❍	❍	❍	❍	❍
Drugs for diabetes (non-insulin) (22)	❍	❍	❍	❍	❍	❍	❍
Over-the-counter (OTC) drugs (23)	❍	❍	❍	❍	❍	❍	❍
Drugs for neuropathy (nerve pain) (24)	❍	❍	❍	❍	❍	❍	❍

Q14 As a reminder, the question being asked is: In general, how beneficial do you consider this item or activity to be?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Prostate screening tests (1)	❍	❍	❍	❍	❍	❍	❍
Mammogram (2)	❍	❍	❍	❍	❍	❍	❍
Heart surgery (3)	❍	❍	❍	❍	❍	❍	❍
Medical x-rays (4)	❍	❍	❍	❍	❍	❍	❍
Self-monitoring of blood glucose (using lancets) (5)	❍	❍	❍	❍	❍	❍	❍
Acupuncture (6)	❍	❍	❍	❍	❍	❍	❍

Q15 Again, please answer the following question: In general, how beneficial do you consider this item or activity to be?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Cell phones (1)	❍	❍	❍	❍	❍	❍	❍
Cigarette smoking (2)	❍	❍	❍	❍	❍	❍	❍
High-fat foods (3)	❍	❍	❍	❍	❍	❍	❍
Automobiles (4)	❍	❍	❍	❍	❍	❍	❍
Air travel (5)	❍	❍	❍	❍	❍	❍	❍
Coffee (6)	❍	❍	❍	❍	❍	❍	❍
Electronic cigarettes (7)	❍	❍	❍	❍	❍	❍	❍
Household cleaners (8)	❍	❍	❍	❍	❍	❍	❍
Food additives (9)	❍	❍	❍	❍	❍	❍	❍
Alcoholic beverages (10)	❍	❍	❍	❍	❍	❍	❍
Moderate-intensity exercise (11)	❍	❍	❍	❍	❍	❍	❍
Artificial sweeteners (12)	❍	❍	❍	❍	❍	❍	❍
Pesticides (13)	❍	❍	❍	❍	❍	❍	❍
High-sugar foods (14)	❍	❍	❍	❍	❍	❍	❍
Genetically modified foods (15)	❍	❍	❍	❍	❍	❍	❍
Nuclear	❍	❍	❍	❍	❍	❍	❍

power plants (16)							

Q34 The questions below ask about your diabetes self-care activities during the past 7 days. If you were sick during the past 7 days, please think back to the last 7 days that you were not sick.

Q16 Diet

	0 Days (1)	1 Day (2)	2 Days (3)	3 Days (4)	4 Days (5)	5 Days (6)	6 Days (7)	7 Days (8)
How many of the last SEVEN DAYS have you followed a healthful eating plan? (1)	❍	❍	❍	❍	❍	❍	❍	❍
On average, over the past month, how many DAYS PER WEEK have you followed your eating plan? (2)	❍	❍	❍	❍	❍	❍	❍	❍
On how many of the last SEVEN DAYS did you eat five or more servings of fruits and vegetables? (3)	❍	❍	❍	❍	❍	❍	❍	❍
On how many of	❍	❍	❍	❍	❍	❍	❍	❍

the last SEVEN DAYS did you eat high fat foods such as red meat or full-fat dairy products? (4)								

Q18 Exercise

	0 Days (1)	1 Day (2)	2 Days (3)	3 Days (4)	4 Days (5)	5 Days (6)	6 Days (7)	7 Days (8)
On how many of the last SEVEN DAYS did you participate in at least 30 minutes of physical activity? (Total minutes of continuous activity, including walking). (1)	❍	❍	❍	❍	❍	❍	❍	❍
On how many of the last SEVEN DAYS did you participate in a specific exercise	❍	❍	❍	❍	❍	❍	❍	❍

session (such as swimming, walking, biking) other than what you do around the house or as part of your work? (2)								

Q19 Blood Sugar Testing

	0 Days (1)	1 Day (2)	2 Days (3)	3 Days (4)	4 Days (5)	5 Days (6)	6 Days (7)	7 Days (8)
On how many of the last SEVEN DAYS did you test your blood sugar? (1)	❍	❍	❍	❍	❍	❍	❍	❍
On how many of the last SEVEN DAYS did you test your blood sugar the number of times recommended by your health care provider? (2)	❍	❍	❍	❍	❍	❍	❍	❍

Q20 Foot Care

	0 Days (1)	1 Day (2)	2 Days (3)	3 Days (4)	4 Days (5)	5 Days (6)	6 Days (7)	7 Days (8)
On how many of the last SEVEN DAYS did you check your feet? (1)	❍	❍	❍	❍	❍	❍	❍	❍
On how many of the last SEVEN DAYS did you inspect the inside of your shoes? (2)	❍	❍	❍	❍	❍	❍	❍	❍

Q21 Have you smoked a cigarette--even one puff--during the past SEVEN DAYS?

❍ Yes (1)

❍ No (2)

If No Is Selected, Then Skip To End of Block

Q22 How many cigarettes did you smoke on an average day? Please enter your response as a whole number (ex. 8) in the box below.

Q23 Please answer how much you agree or disagree with the following questions. In general, I believe that:

	Srongly Disagree (1)	Disagree (2)	Undecided (3)	Agree (4)	Strongly Agree (5)
I know what part(s) of taking care of my diabetes that I am dissatisfied with. (1)	❍	❍	❍	❍	❍
I am able to turn my diabetes goals into a workable plan. (2)	❍	❍	❍	❍	❍
I can try out different ways of overcoming barriers to my diabetes goals. (3)	❍	❍	❍	❍	❍
I can find ways to feel better about having diabetes. (4)	❍	❍	❍	❍	❍
I know the positive ways I cope with diabetes-related stress. (5)	❍	❍	❍	❍	❍
I can ask for support for having and caring for my diabetes when I need	❍	❍	❍	❍	❍

it. (6)					
I know what helps me stay motivated to care for my diabetes. (7)	❍	❍	❍	❍	❍
I know enough about myself as a person to make diabetes care choices that are right for me. (8)	❍	❍	❍	❍	❍

Q25 What is your current age in years? Select "I prefer not to answer" found at the bottom of the drop down list if you do not wish to share your age.
- ❍ 21 (1)
- ❍ ...
- ❍ 100 (80)
- ❍ I prefer not to answer (81)

Q26 Gender
- ❍ Male (1)
- ❍ Female (2)
- ❍ I prefer not to answer (3)

Q27 At what age were you first told you had diabetes?
- ❍ 0 (1)
- ❍ ...
- ❍ 100 (101)

Q28 Relationship Status
- ❍ Single (1)
- ❍ Married (2)
- ❍ Divorced (3)
- ❍ Separated (4)
- ❍ Widowed (5)
- ❍ Committed Relationship (unmarried) (6)

Q29 Current Weight:
Pounds (1)

Q30 Current Height:
Feet (1)
Inches (2)

Q31 We are interested in knowing your most recent hemoglobin A1C (HbA1C) and the date it was measured. The HbA1C is a measure of long-term diabetes control and is written as a percentage. Do you know your most recent HbA1C value?
- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To Annual Household Income

Q32 Please enter your most recent HbA1C value and the date it was measured. If you are unsure of the date of your most recent HbA1C test, please leave the date space blank.
HbA1C % (1)
Date HbA1C Measured (mm/dd/yyyy) (2)

Q33 Annual Household Income:
- ❍ Less than $10,000 (1)
- ❍ $10,000-$19,999 (2)
- ❍ $20,000-29,999 (3)
- ❍ $30,000-39,999 (4)
- ❍ $40,000-49,999 (5)
- ❍ $50,000-59,999 (6)
- ❍ $60,000-69,999 (7)
- ❍ $70,000-79,999 (8)
- ❍ $80,000-89,999 (9)
- ❍ $90,000-99,999 (10)
- ❍ $100,000-109,999 (11)
- ❍ $110,000-119,999 (12)
- ❍ $120,000-129,999 (13)
- ❍ $130,000-139,999 (14)
- ❍ $140,000-149,999 (15)
- ❍ greater than or equal to $150,000 (16)

Q34 Highest level of education completed:
- ❍ Less than high school (1)
- ❍ High school graduate or GED (2)
- ❍ Some college, community, or technical school (3)
- ❍ Community or technical school graduate (4)
- ❍ College graduate (5)
- ❍ Master's degree (6)
- ❍ Doctoral degree (7)

Q35 Have you ever had a visit with a certified diabetes educator (CDE)?
- ❍ Yes (1)
- ❍ No (2)
- ❍ Unsure (3)